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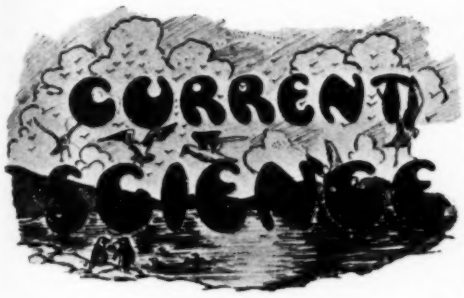

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CONTENTS.

Nutrition Research in India.

THE contributions of Major-General Sir R. McCarrison to our knowledge of nutrition in India form an impressive record of great scientific and practical value, and his retirement from service about the second week of last month has deprived this country of a devoted scientist whose selfless labours have won for him not only public recognition but the personal esteem of all who have come into contact with him. His researches on the thyroid gland in health and disease opened a new and fruitful field of enquiry into the science of nutrition and it is perhaps with this branch of knowledge that Sir Robert McCarrison's name will chiefly be remembered by posterity. He is probably the first medical officer who formulated a synthetic conception of the effects of faulty food on animal organs and tissues in relation to the endocrine regulations of metabolism. As early as 1919, he observed that faulty nutrition led to the degeneration of the cellular activities of the gastro-intestinal tract and a general lowering of the digestive capacity, which, besides diminishing the economic efficiency of man, exposed him to the insidious attacks of disease. This is undoubtedly a significant contribution to our knowledge of the rôle of nutrition in preventive medicine. In fact the latest investigations which have built up our knowledge of nutrition are detailed amplifications of the facts emphasised by Sir Robert McCarrison in his *Studies in Deficiency Diseases* published in 1921 ; and his other works such as *The Life Line of Thyroid Gland* and *The Thyroid Gland in Health and Disease* form an illuminating chapter in the history of medical research in India.

The medical profession and even the common people recognised from the earliest times the close relationship between food and disease, and numerous aphorisms on the subject testify to the general experience of such intimacy between diet and health. But the science of Dietetics which is comparatively new, is the outcome of the co-operative labours of physiologists, biochemists and medical men, and presents problems of vital importance to economists and administrators. For instance, the question of feeding a heterogeneous population in a country like India must necessarily involve detailed investigations of complex issues of an economic and agricultural

character, and as our information on the actual requirements and standard of national diet is rendered more definite and accurate by the progress of research, then it is obvious that such knowledge is bound to influence agricultural policies. The diet of a people affects their welfare no less than it determines the character of their agriculture. In India the choice of food is limited by religious dogmas, and where the ideal of a large section of the people is to suppress the cravings of the flesh as a necessary preparation for the attainment of eternal bliss, considerations of the energy value of different classes of food and the adequate supply of this energy for the maintenance of national well-being and economic efficiency, are subordinated to religious injunctions. Apart from orthodox sentiment, climatic conditions probably exercise an equally great influence on the choice of food by the people, but, generally speaking, there can hardly be any choice among the poorer class of the Indian population. In a tropical climate the resistance capacity of the people is always poor. This is due mainly to insufficiency of food or to wrong selections, and accounts for the prevalence of certain well-known diseases which assume an epidemic form whenever famine and drought fall upon the land.

The problem of food has a deeper significance for Indians than perhaps for any other nation. The people inhabiting certain provinces have been declared unfit for military service and the ultimate cause of the alleged incapacity is as much due to diet as to the meaningless social customs prevalent among them. The progress of foreign education in India is creating an increasingly large community of cultured people whose food, dress and general habits of life differ from those ot their grandparents and of their less favoured countrymen. The general impression is that the cultured Indian is less hardy, and therefore prone to certain types of maladies. In the Pre-British days there was intensive indigenous education in India, but there is no record to show that learning undermined the physical efficiency of even the most cultured among the Pandits and their disciples. The introduction of a foreign system of education differing from the cultural traditions of the people must upset the mental and constitutional make-up of its recipients and the reaction is expressed in diminished functional efficiency and capacity for resistance. Severe strain and anxious suspense attend modern educational methods which, while attempting to enrich the mind, generally succeed in undermining the physical vitality of the younger generation. We have not so far devised any means of combating the evil. The remedy does not lie so much in encouraging games and sports as in the provision of a well-balanced diet for students in order adequately to equip them to cope with the undue mental exertion which they put forth for meeting satisfactorily the unconscionable standards of public examinations. At present the medical inspection of school pupils and college students is concerned more with the detection of diseases from which they suffer, than in the investigation of the causes which produce them. This is not all. A very large body of ministerial officers and officials is engaged in carrying on the sedentary work of government offices, banks and business firms, and they, like the students, suffer equally from deficiency of diet. The poorer classes have no choice, and generally their food is as bad as bad can be. The problem of feeding India is extremely complicated, and Sir R. McCarrison's researches deal with one aspect of it. We still require an authoritative body of scientific knowledge of the physiological value of the different kinds of food consumed by the Indian people, in relation to their occupations, levels of income, the climatic conditions and the general habits and physical constitution of the indigenous population.

In his farewell address which he gave at Coonoor on 18th March, Sir R. McCarrison pointed out that in his laboratories he kept 1,000 stock rats from which, during the last four years, disease was practically excluded by careful attention to three environmental conditions, cleanliness, comfort and food. Race horses and prize dogs are tended with greater love and care than perhaps even Sir McCarrison's rats. But is there any district where 100 school-going pupils enjoy a fraction of the cleanliness, comfort and perfect food which are bestowed on animals? The tendency of modern competitive civilization is that man will sacrifice everything for the gratification of his vanity, and will almost completely ignore what will promote the health and efficiency of human stock. It seems to us that the warning given by Sir R. McCarrison, "The child is made up of what he eats" is a prophetic utterance, for the nation that neglects its children paves the way for self-extinction.

The main problem of the masses of Indian population is what foods they have to buy in order to obtain the greatest possible nutritive value out of a given amount of money each week. We have a vast body of carefully tested information regarding the nutritive value of the various types of food as well as their physiological value, and the experimental researches of scientists have established standards of nutrition. But the great majority of the people either on account of ignorance or of economic reasons are unable to work these standards into their daily meals. Thus the welfare of the nation which depends basically on how its people eat becomes a matter of chance, instead of being part of a definite economic and social policy of Government. The food requirements of a nation must necessarily lead to the carefully planned adjustment of agriculture, but unfortunately agricultural policy in India is not correlated with the science of nutrition. Obviously all these elements constitute a single great administrative problem and what the people want is a plan which is complete, simple and flexible enough to suit different levels of income. A plan such as we contemplate involves the necessary adjustment of production to consumption by families in the home which is the part that means most for the social welfare and the economic efficiency of the working classes. The cultivator therefore has to produce the right kinds and the appropriate quantities of food. On the other hand the consumers must have a definite knowledge of the facts about the diet in relation to health, the standards of food nutrition and the fundamental principles guiding the selection of a diet that promotes health and safeguards against diseases. Every individual is entitled to have an optimum diet though not to a Dukedom. We are thus confronted with the problem of the need and possibility of building up a physically better, healthier and more vigorous population in India by means of better nutrition. The first step in the solution of this question is the consideration of costs, and we have therefore to prepare dietetic patterns at different levels of nutritive content and cost. What we really want is clear and usable statements of the foods to buy and the quantities needed for every class of people suited to their incomes. The scientists have to deal not with the food which an ample purse can buy, but with that for which people have to rake and scrape and count every pie they spend and then do not have enough to go around.

The common practice in India is to cook food containing strong organic acids and alkaloids in vessels made of brass, copper, bell-metal, iron, tin and aluminium at very high temperatures, and cooked food is also stored in these metallic vessels for very long periods of time. The Biochemistry Department of the Indian Institute of Science has been conducting a series of interesting experiments on the effects of food cooked in the various kinds of metallic vessels on the general health and biological efficiency of rats, and the results that have so far been obtained tend to establish that foods cooked in earthen pots promote and preserve the health of rats, while those fed on food prepared in metallic vessels develop a predisposition to ill-health and premature senility. These researches are of the greatest significance to the general public and one of the reasons for the poor physique of the richer and the middle classes of Indian population may be the slow and insidious contamination of food by metals. The prejudice in favour of metallic vessels is too deep-rooted to be removed by scientific researches, and further, this problem is so intimately connected with important metal industries, that sudden discontinuance of all metallic utensils on a wide scale is bound to produce economic dislocation, unless some other lucrative and cheap industry can be substituted in their place.

It may be that nobody in India actually starves in the broad sense of the term, but many Indians live and must live on diets that are an outrage to the known needs of the human organism. The very fact that this basic thing,—adequate and proper food,—is not now within the reach of a large section of our people is a reproach to our social and economic organisation. Nutrition experts have to devise a dietetic plan for poor people which would enable them to secure the full nutritive value out of the foods which they can buy, and which will keep them in health and reasonable comfort. Starting with such a plan, it would be easy to frame other patterns suitable to the different social strata with varying incomes; but the fundamental point is that social justice and commonsense emphasise that every individual is entitled to work, to earn his wages and to eat in order that he might have the strength to gain his bread on the morrow. The case of the school-children

and college students is perplexing. We have no reliable information in regard to the influence of the mental strain and worries on their physical constitution nor do we possess any on the adequacy or otherwise of the food they consume. The general complaint that University education tends to lower the physique of the Indian graduates and that a highly educated person has a diminished capacity of resistance presents an important problem for investigation. Another equally important question for enquiry is why certain races in India are considered unfit for military service. In cases of emergency the State ought to be able to mobilise the whole man-power of the country for defence, and in times of peace, every person must have sufficient strength to protect the honour of his family and his property. Faulty food and the insufficient supply of perfect food must account, at least partly, for the poor vitality and physical strength of this particular group of people. If the whole nation is to be fit and vigorous, then it is clear that food is the starting point.

The question of feeding India for national efficiency is sufficiently important to warrant the creation of certain new departments such as the Bureau of Food Economics and the Agricultural Adjustment Board which would have to work in closer collaboration with the Nutrition Research Laboratories at Coonoor and with the Provincial Agricultural Departments. The first step is to work out a set of figures showing the amount of land that would have to be devoted to various food crops for each of the different dietary plants, assuming that they will be universally used by the Indian population. These figures will naturally include not only crops used directly for human food but also crops necessary to feed the required dairy and work animals. A close relationship has thus to be established between dietary habits and agricultural practice.

Education must go hand in hand with the spread of sound knowledge of diet so as to ensure that every poor family in India acquires enough information to make a correct selection of food and improve food habits. For this purpose the vernacular newspapers and magazines should constantly emphasise the importance of perfect diet and its relation to national efficiency; perhaps the radio will be of immense service in improving Indian dietary as a whole. In their eagerness to be well and to be at their best, people will readily accept misleading information and one of the chief concerns of the new departments suggested, will be the raising of the dietary standards as one of effective propaganda. It is made the easier by the fact that good diet or even optimum diet is not out of line with the average Indian food habits, even though the emphasis may be different. In India, the food of the poor man has to be investigated as carefully as milk has been investigated, and this new work has to define accurately the needs of the poor for various food elements, determine their functions and uses in the body, and perhaps discover, if possible, new elements. This is the only way in which we can plan diets intelligently, weighing both economic and nutritive values. The difference between the diet of the poor man and of the rich man may after all be one of cost, but scientifically there is a unity of interest, *viz.*, the need for well-being. This seems to be the cardinal truth of the body of man as well as of the society of men. The wise management of a family may be an individual's concern, but the maintenance of the national well-being is absolutely the task of government.

Research on Bananas.

AT the instance of the Government of Madras a scheme for the improvement of the Banana has been sanctioned by the Imperial Council of Agricultural Research, Delhi, at a cost of Rs. 74,000, spread over 5 years, in the first instance.

The Banana Research Station will be located at Coimbatore where considerable preliminary work has been done.

The problems of investigation will be the survey and classification of varieties, study of the keeping quality of the fruit, standardisation of the best methods of cultivation, conducting of manurial experiments both for quality and quantity, selection of pure lines involving new and desirable types, methods of transport, study of the banana diseases and their control, preparation of banana products like flour, "fig", jam, preserve, etc.

A Note on *Blaise Pascal* (1623-1662).

A Forerunner of Leibnitz and Newton in the Discovery of the Calculus.

By D. Ferroli, S.J., D.Sc.

IN 1628 the Jesuit Mersenne propounded a question to Mathematicians, *i.e.*, the finding of the area of the cycloid. The problem was the object of protracted researches on the part of many Mathematicians. Towards the middle of the century *Blaise Pascal*, already famous for his physical discoveries, set himself the task of combating atheists. One day, as his niece Marguerite Périer tells us, he suffered from a violent toothache. To find relief from physical pain he concentrated his attention on Fr. Mersenne's problem. He solved it, and incidentally found the Infinitesimal Calculus.

He pondered long over his discoveries, and in June 1658, in a letter addressed to all geometers of repute, under the *nom de plume* Amos Dettonville, he asked them to (*a*) find the area of a segment of a cycloid, (*b*) its C.G., (*c*) the volume of the solids it generates in revolving round its axis and round its base, (*d*) their centres of gravity, as well as the centres of gravity of the halves of the said volumes supposed to be intersected by a plane through their axis.

Later on he discovered that the problems had been solved by Roberval. He withdrew them, and decided that a competition should be held only on the problems under (*d*). However, in his "*Histoire de la Roulette*" and in his "*Recit de l' examen et du jugement des écrits envoyés pour le prix*" he forgets that Amos Dettonville (*i.e.*, himself) had propounded also the problems under (*a*), (*b*) and (*c*), thus occasioning long misunderstandings with his rivals. He wrote then that he had found for himself "methods for determining the size and centres of gravity of solids, of plane and curved surfaces, and of curved lines which he believed would apply almost to everything".

In a letter to M. de Sluse of December 1658 Pascal again speaks at some length of "the wonders of the new analysis," of which he formulated some principles, though he did not endow it with proper symbols. However, the mathematical thought of the times was definitely turning towards the "new analysis". Archimedes' "*Method of Exhaustions*" was well known, and so was Cavalieri's "*Method of Indivisibles*" as can be seen in the works of Napier, in Fermat, in Wallis and others. According to Chevalier, Pascal's most recent biographer, he was the first to determine the sum to infinity of a series of infinitely small quantities, though, according to other historians, the priority must be given to others. In the "*Traité des sinus du quart du cercle*" Pascal deals with the so-called "*characteristic triangle*", which is a trilinear figure "infinitesimally small", contained between two straight lines at right angles to each other, and an arc of a circle, limited by them.

Now Leibnitz owns that he arrived at the idea of a *differential* in studying the "characteristic triangle". Also the formulæ of the Calculus are discernible in the annotations made by Leibnitz to Pascal's work.

We are all acquainted with Pascal's *Arithmetical Triangle.*

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1
1  1
1  2  1
1  3  3  1
1  4  6  4  1
1  5 10 10  5  1  etc.
```

Perhaps the inventor was not Pascal, but Tartaglia. At any rate, Pascal drew from the triangle the determination of *numerical orders*, the calculation of *combinations* and *permutations*, the beginnings of the theory of *probabilities*, the co-efficients of Newton's *binomial theorem*, the first principles of *statistical science*, and the "*Potestatum numericarum Summa*". It was from this that he set out the main rules of integration.

Thus the formula

$$\int_0^x x^p dx = \frac{x^{p+1}}{p+1}$$

is enunciated by Pascal as follows: "The sum of the same powers of a certain number of lines is to the power immediately above the highest of them as the unit is to the index of this same power"—*i.e.*, in modern notation,

$$\frac{\int_0^x x^p dx}{x^{p+1}} = \frac{1}{p+1}.$$

From this he could easily estimate parabolic areas. In fact, to choose a simple example:

$$\int_0^1 x^2 dx = \frac{x^3}{3} = \frac{1}{3}.$$

Pascal's method is more elaborate.

In estimating the area contained between the axis of x, the ordinate parallel to Oy, when $x = 1$ and the curve $y = x^2$, he divides the abscissa into n equal intervals between 0 and 1, and he obtains a series of rectangles, whose horizontal sides are all equal to $\frac{1}{n}$, and whose vertical sides are $\left(\frac{1}{n}\right)^2, \left(\frac{2}{n}\right)^2, \left(\frac{3}{n}\right)^2 \ldots$

The sum of the rectangular areas is

$$\frac{1}{n}\left\{\left(\frac{1}{n}\right)^2 + \left(\frac{2}{n}\right)^2 + \cdots + \left(\frac{n}{n}\right)^2\right\} = \frac{1^2+2^2+\cdots+n^2}{n^3} = \frac{\left(1+\frac{1}{n}\right)\left(2+\frac{1}{n}\right)}{6}.$$

When n is extremely large this is practically equal to $\frac{1}{3}$. It is rigorously equal to $\frac{1}{3}$ for $n = \infty$.

Pascal's quick mind noticed that the result is not altered if *one*, or a *finite number* of rectangles is omitted. In fact

$$\operatorname{Lt}_{n\to\infty} \frac{1^2+2^2+\cdots+n^2}{n^3} = \operatorname{Lt}_{n\to\infty} \frac{1^2+2^2+\cdots+(n-p)^2}{n^3}$$

for p finite.

Hence his fundamental principle that "the sum of an infinitely great number of infinitely small quantities may have a finite value, while the sum of a finite number of infinitely small quantities is always infinitely small, and therefore can be neglected with respect to the finite magnitude under consideration". Of course, the sum can be neglected because it is of a lower order of infinity.

The principle—with which modern mathematics have made us quite familiar—is enunciated in the treatise "*Potestatum numericarum Summa*", which was composed in 1654. Pascal says there: "A continuous magnitude of a given order is not increased if there be added to it, up to any required number, magnitudes of a lower order of infinity. Thus points add nothing to lines, or lines to surfaces, or surfaces to solids, or roots do not count in relation to squares, squares in relation to cubes; so that magnitudes of a lower order should be neglected as of no account."

From this mathematical principle Pascal rose to the following stupendous consideration: "All the bodies in the Universe cannot give rise to even the least of minds; and with all that minds can produce, they can never give rise to the least impulse of charity." This is clear, for bodies, minds and charity belong, as it were, to different orders of infinity—the material, the spiritual, the supernatural—, and one is as nothing when compared with the other.

Leibnitz pondered deeply on these thoughts, and in an unpublished fragment, where he transcribed Pascal's notions of twofold [and manifold] infinities, he added: "What Pascal has just said about the twofold infinity is only an introduction to my system [of the infinitesimal Calculus]".*

It is, perhaps, worth while transcribing here Pascal's famous thought—one of the most complete—where he discourses and meditates on the infinitely great and the infinitely small. "Let man contemplate the whole realm of nature in its full and exalted majesty, turning his eyes away from the base objects that surround him on all sides. Let him lift his glance to this dazzling light, placed like a lamp to illumine the universe to all eternity; let the earth appear to him but as a point in the vast circle described by this luminary, and let him pause to wonder at the fact that this vast circle itself is but a tiny point compared to that described by the stars revolving in the firmament. But if man's view be arrested there, let his imagination pass beyond this point, and it will exhaust its powers of conception, before nature has exhausted its supply of concepts. This whole visible world is but a speck on the broad bosom of nature. No image can do it justice, and however we may enlarge our conceptions beyond all imaginable space we create but atoms in comparison with the actual realities. It is a sphere, whose centre is everywhere, and its circumference nowhere. It is, in short, the greatest characteristic available to sense of the almighty power of God that our imagination should lose itself in the thought.

"Then, returning to himself, let man consider what he is in comparison with all this expanse of being; let him regard himself as lost in this remote province of nature, and from the little cell wherein he has his

* *Cf.* Baruzzi, *Leibnitz et l'organisations religieuse de la terre*, pp. 224-30.

abode, the universe, let him learn to estimate aright the earth, its kingdoms, its cities and himself. What is man in the infinite?

"But to show him another marvel, no less astonishing, let him examine the minutest things he knows. Let him consider a mite and note the tiny body composed of parts incomparably more minute: the limbs with joints, the veins in the limbs, blood in the veins, humours in the blood, drops in the humours, and vapours in the drops. Let him again divide these parts, exhausting his powers of imagination, and he may think he has arrived at the most extreme diminutive in nature. Then I will open before him a new abyss. I will depict for him not only the visible universe, but all the immensity of nature imaginable in the enclosing envelope of this minute atom. Let him see therein an infinity of universes, each with its firmament, planets and earth in the same proportion as in the visible world. In each earth animals, down to the midget existences that show him all that he has already seen in the first. However many he may see he will find in all the same unending, unresting purpose, and he will lose himself in all these marvels, as wonderful in their minuteness as the others in their immensity, for who will not be amazed to realise that our human body just now perceived to be but an imperceptible atom in an insignificant planet of the universe, now becomes a colossus, a world, a vast whole with regard to the nothingness into which we cannot penetrate?

"Whoever sees himself in this way will be terrified of himself, and, considering how he is upheld in the material substance nature has given him between the two abysses of the infinite and nothing, he will tremble at the sight of such marvels; and I think that as his curiosity changes into wonder he will be more disposed to contemplate them in silence than to presume to investigate them.

"For after all, what is man in nature? A nothing compared with the infinite; a whole with regard to nothing, a mean between nothing and everything. Infinitely far removed as he is from understanding either extreme, to him the end of all things and their beginnings are hidden in a baffling, impenetrable mystery; he can see neither the nothingness whence he was taken, nor the infinity in which he is engulfed."

The Theory of Valency: Development and Problems.

By R. Samuel, Dr.Phil. (Goettingen),
Nizam Professor of Physics, Muslim University, Aligarh.

DURING the last century chemistry built up the system of molecular structures as we know it to-day. Firstly and mainly it is characterised by the phenomenon of "saturation of valency". The chemical forces of the atoms were described by valency bonds which represented the number of valencies of each atom, two of these bonds were able to combine two atoms in chemical union, and molecules with unsaturated valencies existed only under abnormal conditions as in free radicals or in many unsaturated molecules such as BeF, BeH, AlH, CH, etc., which the physicist observes in the electric arc or in the discharge tube. It was of course necessary to assume that many atoms possessed different valency numbers but modern atomic physics has furnished such a simple and obvious explanation of this phenomenon, that we do not see any difficulty in this second assumption to-day. The simple rules worked out by Chemistry during the last century meet the requirements of all primary molecules.

Chemistry, however, was unable to give any explanation of the mechanism of chemical combination in either case, and had to be content to introduce names only for the unexplained chemical forces, such as affinity, forces of valency and so on, which could not be identified with those physical forces known at the time. Whereas Chemistry gave us a full answer to the question, *which* chemical union occurs if atoms approach each other, the question *why* it occurs and why it occurs just in this way could only be successfully taken up a century later by modern atomic physics. From the moment onwards when Bohr's theory of the structure of atoms made its appearance in 1913, it was clear that it could be only a question of time until the explanations of the problems would be found. The development took place in two steps. During the reign of the pre-wavemechanical quantum theory of the atom, heteropolar molecules could be explained and many of their properties quantitatively calculated and also some preliminary

models of homopolar molecular structures could be developed. Wave-mechanics opened the second epoch by explaining and (in some cases) directly calculating the forces which keep the neutral atoms of a homopolar molecule together and we may say that we have already advanced to a rather complete physical understanding of the principles involved in the chemical behaviour of atoms and molecules, even if many questions concerning details cannot fully be answered in the present moment.

In 1916 Kossel and Lewis simultaneously and independently put forward two theories, closely related to each other. The starting point of Kossel[1] was, that the number of outside electrons of free ions as they exist in solutions is identical with that of the nearest rare gas. Thus in sodium chloride the sodium atom has lost its eleventh electron and the positive sodium ion remains with the configuration of neon whereas the chlorine ion has gained this electron and has raised its electronic configuration to that of argon, which follows one step in the periodic system. Representing the outside electrons in the usual way by little dots (leaving the inner shells aside) we may represent this process by the following formula:

$$Na\cdot + .\ddot{\underset{\cdot\cdot}{Cl}}: = [Na]^+ [:\ddot{\underset{\cdot\cdot}{Cl}}:]^-$$

He therefore assumes that the electronic configuration of the rare gases is not only inert in a chemical sense but that also a peculiar physical stability is due to it, so much so that in the process of adding an electron to the neutral chlorine atom in excess of its nuclear charge, energy is liberated. This conception serves very well the demands of the heteropolar molecules which are made up of ions. The forces of the electrovalent link are therefore successfully identified with electrostatic forces between ions. Kossel uses it also in explaining homopolar linkages; it is, however, only fair to mention, that he considered this always as a first approximation only and hoped to overcome the obvious difficulties by considering the ions not as rigid balls but as capable of mutual polarisation.[2] This idea, so to speak the next approximation of Kossel's theory, was extended by Fajans and his collaborators. In the meantime, however, Kossel was able to explain certain details of chemical behaviour without a special model of the homopolar linkage; thus the *maximal* valency number of nitrogen or phosphorus is 3 in combination with positive partners as in PH_3, NH_3, AlN, etc., because three electrons are missing for the completion of the configuration of the *following* rare gas, but it is 5 in combination with negative partners like in N_2O_5 or PCl_5 because these atoms possess 5 electrons more than the *preceding* rare gas. This agreement between valency number and the number of outside electrons shows that certain features even of the application of Kossel's theory to homopolar linkage cannot be overlooked in a definite formulation of a theory of valency.

Lewis[3] also started from the apparent stability of the eight-electron configuration of the higher rare gases. The main feature of the theory is, however, a special conception of the homopolar linkage which made it extremely useful in the hands of the organic chemist. From the fact, that nearly all stable homopolar molecules possess an even number of electrons, he concluded that a *pair* of electrons is responsible for each homopolar bond, without actual transfer of charge. The combination of two hydrogen atoms was written as follows:—

$$H. + .H = H:H$$

meaning, that in the molecule both electrons now are under the influence of the field of both nuclei. By this process of "sharing" the electrons, the system of two hydrogen atoms becomes more stable. Lewis believed magnetic forces to be the cause of the electron sharing. He could not know that quantum-mechanics would later reveal a then unknown force by which the "covalent" bond, as it was later called by Langmuir, is produced; but even this was not so far from the truth, since we know to-day that the spin of the electron plays a great part in chemical combination. The model of the hydrogen molecule, however, taken as such, was fully confirmed and substantiated by wave-mechanics.

In Lewis' model of the hydrogen molecule the electrons are redistributed in such a way, that each nucleus is related now to 2 electrons, that is, the number of electrons in the next inert gas, *i.e.*, helium. The combination

[1] W. Kossel, *Ann. d. Physik*, 1916, **49**, 229. *Cf.* the monograph: "Valenzkræfte und Roentgenspektren" (Berlin, 1921).

[2] *Cf.* the discussion in *Zs. Elektrochem.*, Report annual meeting Bunsen Soc., 1928, pp. 24 and 60.

[3] G. N. Lewis, *J. Amer. Chem. Soc.*, 1916, **38**, 762; *Proc. Nat. Ac. Amer.*, 1916, **2**, 586. "Valence and the structure of atoms and molecules," 1923.

of four chlorine atoms with carbon to carbon tetrachloride takes place according to the formula :

$$\cdot\dot{\underset{\cdot}{C}}\cdot + 4\ \cdot\dot{\underset{\cdot\cdot}{Cl}}: = :\dot{\underset{\cdot\cdot}{Cl}}:\dot{\underset{\cdot\cdot}{\overset{\cdot\cdot}{\underset{\cdot\cdot}{C}}}}:\dot{\underset{\cdot\cdot}{Cl}}: \quad \begin{matrix} :\dot{\underset{\cdot\cdot}{Cl}}: \\ \\ :\dot{\underset{\cdot\cdot}{Cl}}: \end{matrix}$$

Thus each nucleus is related to 8 electrons. that is, the number of the outside electrons, in the higher rare gases. He assumed, therefore, that the electrons tend also to form octet configurations in covalent molecules. Thus Lewis' theory contains two postulates : (1) the Duplet Rule which makes the formation of a pair of electrons responsible for each individual bond, and (2) the Octet Theory which assumes the tendency of octet formation. It should be clearly borne in mind, that these two postulates are independent of each other. This is important, because they are also completely inconsistent with each other. It is true that the system of organic chemistry can conveniently be described by the Octet Theory, but this is the automatic result of the prevailing tetravalency of carbon. If each chemical bond is represented by a pair of electrons, then each tetravalent atom will be surrounded by eight electrons in the molecule simply because four times two is eight. Organic chemistry deals only with a few atoms whose varying combination produces more than a hundred thousand molecules. In the periodic table we know, however, to-day 92 atoms, many of which possess different states of valency. Thus the tetravalent carbon atom is one only out of about two hundred cases of valency and every one of them is equally important ; if we want to build up a theory of valency we have just to consider inorganic chemistry which represents a greater multiplicity and variety of chemical combinations. In the moment we leave alone the fourth group and the few cases, where the number of positive and negative valencies is equal and consider any other group of the periodic table, we see that either the Duplet Rule or the Octet Theory has to be abolished. Either the Octet Rule is strictly maintained, then the electrons have to be counted in such a way that their number when surrounding the central atom is increased on the left hand side of carbon in the periodic table and is decreased on its right hand side. This is done by introducing devices such as the semipolar double bond and the singlet linkage. Or the Duplet Rule is strictly maintained, then the number of surrounding electrons is always double the number of valencies, *i.e.*, mostly double the number of *p*-electrons or of $s + p$-electrons of the central atom and the significance of the Octet vanishes. Indeed from here onwards two different schools of thought have been developed on two different lines : the first theory is intimately connected with the names of Langmuir, Lowry, Prideaux, Sidgwick, Sugden a.o.,[4] the second was mainly developed by Grimm and Sommerfeld.[5] Incidentally Lewis himself attributed greater importance to the electron-pair-bond theory of linkage. Thus he states[6] "The striking prevalence of molecules in which each atom has its full quota of four electron pairs in the outermost shell has led Langmuir to attempt to make the Octet Rule absolute, and he even proposes an arithmetical equation to determine, in accordance with this rule, whether a given formula represents a possible chemical substance. I believe that in his enthusiasm for this idea he has been led into error, and that in calling the new theory the "Octet Theory" he over-emphasises what is after all but one feature of the new theory of valency. The rule of eight, in spite of its great importance, is less fundamental than the rule of two, which calls attention to the tendency for electrons to form pairs. The electron pair especially when it is held conjointly by two atoms, and thus constitutes the chemical bond, is the essential element in chemical structure."

Thus the pre-wave-mechanical, naive Quantum Theory gave us a complete understanding of the heteropolar chemical combination (taking the existence of electron affinity for granted) but was not able to explain that mutual interaction of electrons on which the electron affinity itself depends, and the homopolar linkage. Therefore, it was possible to interpret this phenomenon in different ways and two different schools of thought have been developed. One of them maintains the existence of particular stable electronic configurations around each atom

[4] *Cf.* Sidgwick, *Electronic Theory of Valency* (London, 1927).

[5] *Zs. f. Phys.*, 1926, **36**, 36. *Cf.* Grimm's article in *Handb. d. Phys.*, **24**. Lessheim and Samuel : "Die Valenzzahl, etc." (Berlin, 1927).

[6] "Valence etc." Chapter VIII. *Cf. J. Chem. Phys.*, 1933, **1**, 23.

(Octet Theory) but has to resort to different varieties of non-electro-statical linkage. The other one is a uniform theory which maintains the close relation between the number of valencies of an atom and the number of its electrons in its various outside groups and sub-groups and obtains stability in all cases in which the electrons of the central atom not taking part in the linkage form completed groups and sub-groups. We shall see later, that this difference of opinion leads even to-day to two different interpretations of the wave-mechanical treatment of the homopolar molecule, either being logical and self-contained, in such a way that we can decide between them only by comparing their results with experimental evidence.

If we are now going to consider the results achieved by wave-mechanics in recent years, we encounter the same difficulty with which every one who speaks or writes about quantum mechanics is faced. If we are coming to atomic dimensions, matter behaves unexpectedly different from its behaviour known to every one from the experience of daily life. We understand this behaviour in this sense, that we are able to describe it by valid mathematical formulæ and therefore wave-mechanics was able to explain covalent linkage between two atoms. If we take up, however, our leading question again and ask with which physical forces we have to identify now those "forces of valency," we are still at a loss to answer this question. It is—as a matter of principle—not possible to describe this behaviour by an analogy or a model based on daily experience or even in the language which was formed during hundred thousands of years by this experience of the macroscopic world and which, therefore, does not offer us either words or conceptions for such a description. In wave-mechanics, the Hamilton-Jacobi's equation of classical dynamics is replaced by a different equation, the so-called Schrœdinger wave equation. Because the effects in the atomistic world are different from those in the microscopic world, they can be expressed only by a different method of calculating, which we call wave-mechanics and for which this equation is the foundation. In particular, covalent linkage is not due to an attraction of the atoms according to Coulomb's law but to a purely wave-mechanical effect which has no classical analogue but is somewhat similar to the classical resonance phenomenon. If the system of two atoms is degenerated in such a manner that its energy value can be represented in two different ways—*e.g.*, by the exchange of electrons which are identical and whose exchange is therefore without an influence on the energy of the total system—this degeneracy is eliminated so that the common energy value is replaced by two different ones, one higher and one lower than it. The H_2 molecule, *e.g.*, consists of two nuclei (*a*) and (*b*) and two electrons (1) and (2). Electron (1) may be with nucleus (*a*) and electron (2) with nucleus (*b*); the system may have an energy E. The electrons (1) and (2) are indistinguishable, so electron (1) may also be with nucleus (*b*) and electron (2) with nucleus (*a*) and the energy of the system will have the same value E. Wave-mechanics says then that the actual energy value is not E, but there are two possibilities one value lower than E, another higher.[7] The lower one is even lower than the sum of the energies of the two separated atoms and leads therefore to chemical union and the liberation of this energy difference appears as heat of formation. The higher one leads to an elastic collision of the two atoms. The non-elastic impact and chemical union occurs, when the two electrons possess anti-parallel spin vectors, the electrons then going into the same quantum group of the molecule, and the elastic impact occurs in the case of parallel spin vectors. The wave-function of the H_2 molecule, corresponding to the lower energy value, shows a finite probability for the electron of the one atom to be also with the other one and we may interpret this as the analytical representation of Lewis' process of sharing. If on the other hand the same calculation is applied to two unexcited helium atoms, each possessing already two equivalent electrons in the same quantum group, *i.e.*, with counter-balanced spin, no splitting of the energy value occurs and chemical union is not possible. It can take place only between excited He atoms in which the closed group of electrons is fissured and indeed such He_2 molecules formed by excited atoms are spectroscopically known to exist in the electric discharge tube. A closed quantum group always renders the atom chemically inert.

The wave-mechanical calculation, the results of which have been just described, was first given by Heitler and London. Since

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[7] W. Heitler and F. London, *Zs. f. Phys.*, 1927, **44**, 455.

the system of two hydrogen atoms contains four particles, the Schrœdinger equation cannot be solved directly but has to be approximated. In the following table we compare the observed constants of the H_2 molecule with the results of the calculation of Hylleraas,[8] who continued the wave-mechanical treatment with higher approximations.

	Energy of dissociation in electron volts (1 e. v=23 k cal/mol.	Internuclear distance in Angstrom units (10^{-8}cm.)	Moment of inertia in g. cm.^{2}
Calculated	4·37	0·72	$4·28 \times 10^{-14}$
Observed	4·4	0·76	$4·72 \times 10^{-14}$

Wave-mechanically the molecule is described by its wave-function. The method of Heitler and London consists in constructing the wave-function of the molecule by combining those of the separated atoms. Another way of doing it is to consider only the wave-functions of the valency electrons of the separated atoms and to build up that of the molecule from them. This method was successfully used by Slater and Pauling[9] in explaining the valency angle in such molecules as H_2O, in which the valency electrons of the central atom are *p*-electrons.

Both these methods commence with the system of the separated atoms, which are thought to approach each other, their mutual interaction gradually increasing. There is, however, a third method, developed mainly by Herzberg, Hund, Lennard-Jones and Mulliken,[10] which considers the already combined atoms, *i.e.*, the completed molecule from the very beginning and which is called the method of molecular orbitals, an orbital being a quantum group of the molecule. The nuclei are thought to be fixed at a particular internuclear distance together with their cores of inner electrons which do not take part in the chemical linkage, the so-called "atomic orbitals". The outside electrons are added one by one to this skeleton, filling up the "molecular orbitals". Thus the wave-function of the molecule as a whole is constructed by combining those of the single electrons, which from the very beginning are under the influence of both the nuclei.

Ultimately of course all these methods are bound to merge and it should not matter, if the wave-function of the molecule is approximated by separated atoms, decreasing their distance, or by electrons brought in the field of the two nuclei which have already the proper internuclear distance prevailing in the molecule. We are, however, not able to calculate sufficiently high approximations and therefore the results may vary, each method giving a different approximation of the same true wave-function of the molecule. In general we may say that the results of the first two methods, which commence with the separated system, describe better the conditions in the molecule at larger distances of the nuclei, whereas the third method naturally gives better results at lesser distances. Since, however, actual calculation is possible only in the simplest cases, and has to be replaced by generalisation in heavier, poly-electronic molecules, there remains a certain discretion of interpretation, which leads to different theories of valency.

It is obvious that the first and second methods of mathematical treatment lead to an electron pair bond theory of valency; in poly-atomic molecules these pairs of electrons which represent the chemical bond are localised between two nuclei. Only the third method presents different ways of interpretation as to a theory of valency. Chemical linkage is always due to a degeneracy, as described above. In those simple cases, in which actual wave-mechanical calculation is possible, there exist, however, two possibilities. The linkage, *i.e.*, of H_2 may be ascribed either to the degeneracy produced by the equality of the two electrons or to that produced by the equality of the protons. Hund has shown that the latter one is preserved to a certain extent, even when the nuclear fields are not exactly but almost equal. Assuming that chemical linkage is always due to the strict or approximated equality of the *nuclear fields*, we derive a theory of valency in which already the *single* electron produces a bonding effect; if, however, the generalisation is done on the lines, that the equality of the *electrons* produces the degeneracy necessary for chemical linkage, we are led to a *pair bond* theory of valency. In other words, when constructing the wave-function of the molecule by introducing the electrons one by one into the

[8] E. A. Hylleraas, *Zs. f. Phys.*, 1931, **71**, 739.

[9] J. C. Slater, *Phys. Rev.*, 1931, **37**, 481; **38**, 328, 1109; 1932, **41**, 255; L. Pauling, *Phys. Rev.*, 1932, **40**, 891; *J. A. C. S.*, 1932, **53**, 1367, 3225.

[10] G. Herzberg: *Zs. f. Phys.*, 1929, **57**, 601. F. Hund: *Zs. f. Phys.* 1931, **73**, 1, 565; **74**, 1, 429. J. E. Lennard-Jones: *Trans. Farad. Soc.*, 1929, **25**, 668; 1934, **30**, 70; R. S. Mulliken: *Phys. Rev.*, 1932, **40**, 55; **41**, 49, 759; 1933, **43**, 279 a.o.

combined field of the two nuclei, we may either consider them as independent, more or less neglecting their mutual interaction, or we may assume that such an approximation is insufficient for a theory of valency and that the mutual interaction is just the essential point for it. There is no doubt that both effects are always present but which of them prevails normally cannot be decided by the mathematical treatment itself. In any case, whether the wave-mechanical method of molecular orbitals is interpreted as a single electron bond theory of valency or as an electron pair bond theory, a postulate is introduced and the decision has therefore to be arrived at by comparing the results of both views with empirical facts.

It is already possible to calculate some of the important features of a molecule by treating the electrons as independent. The method of molecular orbitals owes its success just to this, that the term system and the electronic configuration of the completed molecule can be derived already in an approximation in which the interaction of the molecules has not to be considered. The results, obtained in this way, have led some authors to believe that the question of chemical linkage may also be reduced to the bonding effect of a single electron in degenerated nuclear fields. This view is supported by the existence of the molecule ion H_2^+ which contradicts any pair bond theory of valency, because only one electron is left and here the linkage is certainly due to the strict degeneracy of the nuclear fields. In poly-atomic molecules the independent electrons are "non-localised" and do not belong to any particular nucleus, and this gives an opportunity to translate the Octet Theory of Chemistry into wave-mechanical language. It requires, however, the additional hypothesis, that the vastly different fields of say, C^{2+} and O^{4+} in CO or Ca^{2+} and F^{5+} in CaF etc. are almost degenerated.

As soon, however, as the nuclei are not protons, just those molecules exist which possess a bonding pair of electrons, as Li_2, LiH, BeH, $(BeH)^+$, but those with one electron only cannot be found even spectroscopically like $(Li_2)^+$ $(LiH)^+$ or $(BeH)^{++}$. Furthermore some molecules possess excited electronic terms in which their energy of dissociation is considerably increased as compared with that for the ground level, and it was found that this phenomenon occurs just with molecules possessing free valencies.[11] It was possible to give a simple explanation from the pair bond view, whereas the other viewpoint is at a loss to explain this phenomenon in a simple way. Similar results obtain with regard to the linkage of atoms, possessing a helium-like configuration of two *s*-electrons, like the atoms of the second group or C in CO_2.[12] The s^2 group acts repulsively according to spectroscopical evidence and wave-mechanical calculation and these bonds can be understood easily in a pair bond theory as arising from excited atoms, whereas the single electron bond interpretation of the theory should expect a different term as the ground level of these molecules. As regards the point of view of chemistry, it has been shown recently that there exists no experiment which proves the Octet Theory and that experimental evidence favours rather a uniform pair bond theory.[13]

The question as to whether non-localised wave-functions, *i.e.*, independent electrons, or localised functions, *i.e.*, electron pairs with strong mutual interaction, describe the molecule better, can be decided by the incapability of the non-localised functions, to describe the process of dissociation. The view of the single electron bond theory leads automatically to an incorrect statement as to the products of this process. If in H_2 the two electrons are treated as independent, the products of dissociation are 50% H+H and 50% $H^+ + H^-$, which of course is far from the truth. The same obtains in poly-atomic molecules. This takes place, because the non-localised wave-function of the molecule contains also the ionic terms of H^+ and H^- in too high a percentage, and this is a direct expression of the independence of the electrons. If the two electrons have no interaction other than a screening effect, then indeed the probability of either electron, to go with one or the other of the nuclei, is always 50% and it does not matter, if the other electron is already in the vicinity of this particular nucleus or not. If there exists, however, a strong mutual influence between the two electrons, the choice of the second electron, to go with a particular

[11] H. Lessheim and R. Samuel, *Zs. f. Phys.*, 1933, **84**, 637; **88**, 276.

[12] H. Lessheim and R. Samuel, *Proc. Phys. Soc.* (London), 1934, **46**, 523.

[13] R. F. Hunter and R. Samuel, *J. C. S.*, 1934, 1180; *Chem. and Ind.*, 1935, **54**, 31. *Rec. Trav. Chim.*, P. B, 1935, **54**, 114.

nucleus, will depend also on the choice of the first one and the probability of going to that particular nucleus, to which also the other electron belongs, will be much less than that of going to the nucleus which is still without an electron. The pair bond interpretation naturally pictures the molecule with a strong interaction inside the electron pairs and a weak interaction from pair to pair. Therefore neither strictly localised wave-functions, in which the interaction from pair to pair is missing and not containing the ionic terms at all, nor strictly non-localised functions without any interaction but with the full weight of the ionic terms are a correct description. Slater therefore could show that in the first wave-mechanical method about which we spoke above, a certain percentage of the ionic terms has to be introduced, or in the molecular orbital method, the excessive influence of the ionic terms has to be cancelled to come to satisfactory results with regard to dissociation. Thus the two views approach each other.[14] Sometimes it was believed that in poly-atomic molecules the localised wave-functions of the pair bond interpretation represent a poorer mathematical approximation. If it would be true that the approximation by non-localised functions is mathematically the better one, this would be indeed a serious argument against the pair bond view. The discussion concerned particularly the linkage between two atoms with one *s*-electron each and a central atom with two *p*-electrons, the linkage $s—p^2—s$, as in H_2O or CH_2. It could, however, be shown that those functions which form the somewhat poorer approximation have still the disadvantage that they yield wrong percentages of dissociation products. If a different procedure, which gives the correct products of dissociation, is followed, wave-functions are obtained which yield not only almost localised bonds but also an improvement of the approximation.[15]

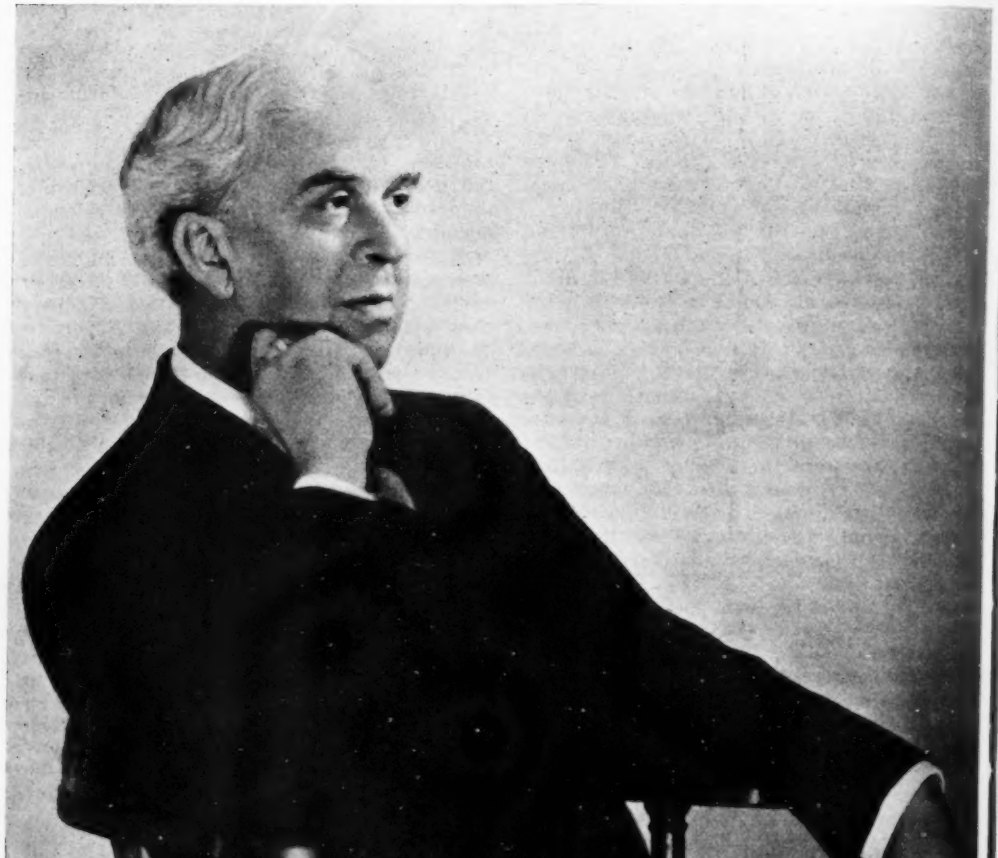
[14] J. H. Van Vleck, *J. Chem. Phys.*, 1933, **1**, 177, 219; 1934, **2**, 20.

[15] H. Lessheim and R. Samuel, *Proc. Ind. Acad. Sci.*, 1935, **1**, 623. *Nature*, 1935, (Febr. 9th), p. 230.

Thus we see that in the method of molecular orbitals two interpretations are possible and these represent just those two schools of thought, which existed already in pre-wave-mechanical theories of linkage. The interpretation by independent electrons is certainly sufficient for the description of the completed molecule, but as soon as any question connected with the transition to greater internuclear distances, *i.e.*, with the dissociation of the molecule arises, the interpretation by the electron pairs is superior both from the viewpoint of mathematics and experimental physics. The theory of valency is certainly concerned more with the process of dissociation or formation than with the description of the completed molecule. Combining all the different points of view, chemical evidence, band spectra, and the analytical representation of the molecule, it can be shown that the pair bond interpretation results in a self-contained theory in which all the difficulties of the other view disappear.[15] To our mind, therefore, the balance of probability rests with the pair bond theory and we have to picture the linkage in a normal molecule like SF_6 as produced by six bonds each of them almost completely localised between the S and one of the F nuclei. There is no difference at all between these six linkages. The real field of application of the non-localised wave-functions and many a beautiful explanation of complicated chemical questions by them is given in the aromatic substances, where indeed the electrons of the benzene ring have to be considered as non-localised, *i.e.*, as belonging equally to all the carbon atoms. The degeneracy of the nuclear fields on the other hand answers mainly for those effects, which are connected with the polarity of the molecule, as the transition from covalent to electrovalent linkage or the inductive effect, used in modern organic chemistry. With these questions we cannot deal here. If, however, we confine ourselves to normal molecules, it appears as if a uniform pair bond theory will answer best the requirements of chemistry and physics.

Major-General Sir Robert McCarrison, Kt., C.I.E., M.D., D.Sc., F.R.C.P.

BY the retirement of Sir Robert McCarrison the Indian Medical Service has lost one of its ablest officers, and this journal a valued contributor and well-wisher. I have endeavoured in this article to give a brief outline of Sir Robert's work in India, with special emphasis on the more important and striking contributions that he has given to medical science.



Major-General Sir Robert McCarrison, Kt., C.I.E., M.D., D.Sc., F.R.C.P.

Sir Robert McCarrison entered the Indian Medical Service in 1901. His first two years of service (1902-1904) he spent in Chitral. It was fortunate that at the outset he met with a problem (Chitral Fever) which stimulated him to observe closely and to deduce. Prior to this, Chitral Fever had been regarded as malaria and treated as such. McCarrison studied it closely and

from its clinical and epidemiological features showed it was not malaria but a hitherto undescribed disease, and he suggested the sandfly as the most likely vector. He showed his Report in 1905 to Sir Patrick Manson who suggested the name "Three-day-Fever of Chitral". McCarrison's descriptions of the fever appeared in the *Indian Medical Gazette* of January 1906. His suggestions were later confirmed by various observers, but to McCarrison would appear to belong the credit of first describing Chitral Fever as a definite entity and suggesting its vector.

On leaving Chitral, McCarrison entered the Foreign and Political Department and was posted to Gilgit. Here he commenced the series of observations and experiments which attracted immediate attention and placed him at once as a research worker and an observer and experimentalist of the first order. In Gilgit he made an epidemiological, clinical, therapeutic and experimental study of goitre, cretinism, deaf-mutism and endemic tetany. Goitre was here endemic in certain villages and McCarrison set himself to study the causes of this endemicity. He observed that the water drunk in such villages was highly polluted, and he produced goitre in himself and on some other human volunteers by drinking night and morning the residue left on the candle of a Berkfeld filter, after filtration, of grossly polluted drinking water, which had passed through a village where goitre was highly endemic. He further showed that goitre thus produced was in its early stages curable by intestinal antiseptics (thymol, etc.) and by shock doses of vaccines (coli, staphylococcus, etc.). In Gilgit also he described a new type of cretinism which was due to involvement of both the thyroid and parathyroid glands. His work here attracted great attention and raised hopes that we had here a worker of first rate capabilities with imagination, insight and originality who would attack problems from an independent view-point; and further work on goitre was confidently awaited. In 1911 he left Gilgit on furlough to England where he was invited to deliver the Milroy Lectures at the Royal College of Physicians in London (January 1913). These lectures were published in book form with the title "*The Aetiology of Goitre*" which is still an excellent resumé of the knowledge up to that time. During this period he studied goitre in the Alps and Switzerland.

He returned to India in 1913 and commenced work with the Indian Research Fund Association, a connection which was maintained uninterruptedly until the present year on his retirement. He first worked at Kasauli on an *Enquiry on Goitre and Cretinism* under the Indian Research Fund Association. This work was largely experimental and he was able to produce goitre in animals under experimental conditions, and what was more important, congenital goitre and congenital parathyroid disease and cretinism in their offspring, the former by feeding the animals either on cultures of fæcal bacteria or a fæcal bacteria from goitrous persons. The congenital manifestations were obtained by feeding the mothers throughout pregnancy on anærobic cultures of fæcal bacteria from goitrous persons. This was the first occasion in which congenital goitre and cretinism had been produced by natural means, as opposed to operative means on the thyroid gland of the mother. During this time also his important study of an epidemic outbreak of goitre in the pupils of the Lawrence Military School at Sanawar was undertaken and the substitution of a pure for a polluted water supply caused the disappearance of the goitre. It will be remembered that later with the co-operation of Newcomb, Norris and Nath, he re-investigated this outbreak from the point of view of iodine content of the local water supplies and found that the old polluted water supply actually contained more iodine than the new one.

It was during this period at Kasauli that McCarrison commenced the study of dietary with which his name has become so widely associated. He began work on the effects of vitamin deficiency in the animal organism, his first observation of importanec being the marked lowering of resistance to infection brought about by vitamin deficient diets.

Then came the war in 1914. McCarrison went to Egypt and was employed as Registrar in a large Indian General Hospital. His experience here was later taken advantage of by the Government of India when he served on a Committee appointed to re-organize Military Hospitals. While in Egypt his health broke down and he was sent to England where he was placed in charge of the Malaria Investigation Hospital. While here he wrote his book *The Thyroid Gland in Health and Disease* (1917). In 1918 he returned to India and was posted to Coonoor where he again began his work

on nutrition which has continued uninterruptedly for the last 17 years. This period of work has been conducted under the auspices of the Indian Research Fund Association which has been quick to recognise opportunities for research in nutrition, generously providing funds year by year for his investigations. To review adequately the whole of the work turned out by McCarrison and his colleagues during these 17 years would take too much space, and I confine myself to indicating what have been in my opinion the main and outstanding features of this work. From 1918 to 1922 there appeared in the *Journal of Medical Research* a series of papers on the Pathogenesis of Deficiency Diseases, which threw a flood of new light on the subject of deficiency diseases. Hitherto the study of these diseases had been mainly clinical. McCarrison instituted a new principle by undertaking complete post-mortem examinations of deficiently fed animals, examinations that included the histopathological study of all organs and tissues of the body. He definitely established the important facts that faulty and ill-balanced dietaries deficient in vitamins lower the resistance of the animal organism to attacks by microbic agents of disease and such faulty food leads to depreciation of cellular function generally throughout the body, specific deficiencies of course causing specific effects.

These two fundamental generalisations have formed the basis of most of the later work in various countries on the pathogenesis of deficiency disease. McCarrison's description of the effect of faulty food deficient in vitamins on the gastro-intestinal tract was an observation of first rate importance, and has been described by Garrison in his *History of Medicine* as "one of the most significant contributions to the rôle of nutrition in preventive medicine". Of high importance too was the demonstrations of the remarkable effects of food deficient in vitamin A and C on the adrenal glands. This work on the depreciation of cellular functions and its results in manifest disease is probably McCarrison's main gift to nutritional science.

His book "Studies in Deficiency Disease" collected his work and his ideas in concrete form. In this he showed that the "deficiency diseases" so called such as scurvy, xerophthalmia, beri beri and the like are but particular manifestations of diet deficiency, but that faulty foods and faulty nutrition resulting therefrom, had a much wider application. The long continued use of diets containing too little of the vitamin factors necessary for optimum health is far more important than a complete deficiency, and is much more widely prevalent in human dietaries. The implications of this truth are becoming more and more apparent, and correction of faulty dietaries would result in the reduction and disappearance of many ordinary diseases, gastro-intestinal, urinary, pulmonary, and others, and especially in many widespread symptoms of disease, which ordinarily are not associated in the mind of the profession or the public with diet and nutrition. McCarrison's experimental work on the dietaries of India is well known, and though appreciated, is not acted on sufficiently.

His healthy rat colony in Coonoor which he has maintained during the last 5 years in perfect health, with no disease except old age and no infantile mortality, has been very impressive, and has been obtained by minute attention to diet, cleanliness and comfort. As he says himself "diet and dirt, including insect vectors of disease, are the two great causes of illness, and they are partners in crime". But in these later years his first love study, goitre, has not been forgotten. On the experimental side he produced (and he was the first to do so) the "lymph-adenoid" type of goitre experimentally, which had been demonstrated by Williamson and Pearse in man. The Memoir of the *Indian Journal of Medical Research* "The Life Line of the Thyroid Gland" in collaboration with Professor Madhava is a masterly piece of work, and will be constantly referred to not only for its informative matter, but as a model of presentation and analyses of experiment, observation, and comment. His crowning work on goitre was the presentation at the request of the Swiss Goitre Commission of the Principal Report on the Aetiology of Goitre at the Second International Congress held at Berne in 1933.* His little book on "Food" was a gift to the children of India and it has now been translated into Urdu, Punjabi, Hindi, Kanarese, Tamil and Malayalam.

It is pleasant to record that Sir Robert has not been without honour, both in his own country, by which I mean here

* For a summary of this Report, see *Curr. Sci.*, 1933, **2**, 133.

India, and outside. In 1911 he was awarded the Kaiser-i-Hind 1st class "for public services in India". In 1916 he was awarded the Prix Amussat by the Academy of Medicine, Paris, with the title of Laureate of the Academy. In 1914 he was appointed a Fellow of the Royal College of Physicians of London. In 1918 he was awarded the B. M. A. Prize for Research, and made an Honorary LL.D. of the Queen's University, Belfast. In 1918 also he was gazetted Brevet Lieutenant-Colonel for distinguished service in the field. In 1927 he was made the Honorary Physician to the King and Brevet Colonel. These last were made in recognition of the work he was then doing, following the publications of the Report of the Royal Commission on Agriculture. These honours were fittingly rounded off by the honour of Knighthood conferred on him by His Majesty the King in 1933. Many other academic distinctions and compliments have been paid to him. He was invited to give the de Lamar (Baltimore), the Mellon (Pittsburg), the Mary-Scott Newbold (Philadelphia), the Mayo-Foundation (Rochester), and other lectures in the U. S. A. of 1921. He was appointed in 1922 one of the 20 Honorary Fellows of the College of Physicians of Philadelphia. In 1931 he delivered by invitation special lectures at the Royal College of Surgeons of London on "The Causation of Stone in India" and "Some Surgical Aspects of Faulty Nutrition."

Sir Robert McCarrison's work in India has been brilliant, inspiring and abiding. His main ambition to establish an Institute of Nutrition in India worthy of the country and of the subject has unfortunately not been fulfilled, but his Unit of Research on Nutrition established at Coonoor, which is one of the oldest in the world, will remain and, we hope, prosper. Those who have heard Sir Robert speak either formally or informally will not forget his distinguished presence, his fine voice, and his polished diction. He is a born and natural orator. His exposition of his subject is ideally clear and interesting and he can use his gifts of speech in persuasion of what he thinks is right and in fearless denunciation of what he thinks is wrong. He was a gifted enthusiast throughout his service and used his talents and energy unceasingly and ungrudgingly in the cause of science and in the cause of India. He loved and loves India and its peoples, and his aim was and is that younger generation of Indian scientists should be given ample opportunities for training and service for the advancement of science in India. His style in writing is lucid, simple, forcible, and telling, and is based to some extent at any rate on an intimate perusal and acquaintance with the Old and New Testaments which he thought models for everyone who wished to improve their speaking and writing in English. As a friend, he combines charm and sincerity and many of us have benefitted by his experience and advice.

Sir Robert McCarrison leaves India with the regret and the best wishes of all his colleagues and thousands of others. We wish him joy in his retirement, but we know he will not be idle. He proposes to settle in Oxford where he will have, we hope, opportunities of passing on to the younger members of our profession what he himself learned and of showing them the paths along which there is still so much to be discovered.

A. D. STEWART.

Director of Nutrition Research in India.

DR. W. R. AYKROYD has been offered the appointment of Director of Nutrition Research in India.

Dr. Aykroyd has held the appointments of House Surgeon and Physician, Adelaide Hospital, Dublin, 1925, and Resident Medical Officer, Government General Hospital, St. Johns, Newfoundland, 1926–1927. While in the latter appointment he undertook an investigation of beri beri and other food deficiency diseases. He was granted a Beit Memorial Research Fellowship 1928–1931, the Fellowship being given for combined field and laboratory work on nutrition. In 1931 he secured appointment as member of the Health Section, League of Nations, Geneva, which he still holds. In connection with a report he prepared in 1933 on 'Nutrition in Relation to Public Health' he visited a number of European countries, the U.S.A. and Canada making personal contact with public health workers interested in the problems of nutrition, and studying methods employed in each country.

Letters to the Editor.

CONTENTS.

Influence of "Swelling" on the Abnormal Unidirectional Diamagnetism of Graphite Crystals.

GRAPHITE crystal (which is hexagonal and has a perfect basal cleavage) exhibits remarkable magnetic and electrical properties. Its diamagnetic susceptibility[1] along the vertical axis is abnormally large, about -22×10^{-6} pergm., while for directions in the basal plane it is practically the same as that of diamond, *viz.*, $-0{\cdot}5\times10^{-6}$. Electrically, the crystal is a good conductor for directions in the basal plane. These abnormal properties may be traced to the peculiar structure of the crystal. While the three equivalent linkages of the carbon atom in the basal plane of the crystal are homopolar, the fourth weak linkage, which binds the widely separated successive layers of carbon atoms, is generally regarded as "metallic". If the large displacements of these "metallic" electrons under the influence of electric and magnetic fields are confined predominantly to the basal plane, the electrical conductivity along the plane, and the abnormal susceptibility for magnetic fields incident along the normal to the plane, receive a natural explanation.

The "swelling" of graphite to "blue graphite" (as also its further oxidation to graphitic oxide) is generally regarded as corresponding to the adsorption of oxygen atoms between the carbon layers, the metallic linkages being broken thereby.[2] We should therefore expect both the conductivity and the abnormal diamagnetism to disappear on "swelling". It is known that the oxidation of graphite destroys its conductivity. Its effect on the abnormal diamagnetism does not seem to have been studied.

A small single crystal of graphite was treated with a mixture of concentrated nitric and sulphuric acids for about 12 hours. The resulting "blue graphite" was washed in running water for over 12 hours and dried in a desiccator. The specimen had the same hexagonal shape as the original graphite piece, and was also found to be roughly a single crystal, as tested by its X-ray diffraction. On measuring its principal diamagnetic susceptibilities it was found that

(1) for directions in the basal plane, its specific susceptibility is practically the same as that of untreated graphite;

(2) on the other hand the magnetic anisotropy, *i.e.*, the difference $\Delta\chi$ between the two principal susceptibilities, which is as high as 22×10^{-6} per gm. in untreated graphite, is now diminished to about $1{\cdot}3\times10^{-6}$ per gm. of carbon; *i.e.*, the abnormal diamagnetism of graphite along its 'c' axis is almost completely destroyed by the "swelling".

It is significant that the above value for the magnetic anisotropy of oxidised graphite is of the same magnitude as in compounds containing condensed benzene nuclei, *e.g.*, pyrene, for which $\Delta\chi=1{\cdot}2\times10^{-6}$ per gm. content of carbon.

Further it is known that as the size of the graphite particle is continually diminished (to that corresponding to "amorphous" carbon), the distance between the successive layers of carbon increases correspondingly. This has been taken by Randall and Rooksby[3] to indicate a weakening of the metallic valency bonds of the carbons. In that case the diminution in the diamagnetism of graphite powder with the particle size, observed by Honda, Paramasivan and others, would be a natural consequence. In this connection the following observation is of interest. Some preliminary measurements made by us on the principal susceptibilities of crystallites of graphite show that, while the susceptibility along directions in the basal plane is practically independent of particle size, and has a constant value near about $-0{\cdot}5\times10^{-6}$, it is the susceptibility along the 'c' axis, which is abnormal in large crystals, which diminishes with decreasing particle size.

K. S. KRISHNAN.
N. GANGULI.

210, Bowbazar Street,
Calcutta,
March 27, 1935.

[1] Guha and Roy, *Ind. Jour. Phys.*, 1934, **8**, 349.
[2] Hoffmann, *Koll. Zeits.*, 1932, **61**, 297. See also Desch, *Chemistry of Solids*, 1934, p. 180.
[3] See Randall, *Diffraction of X-rays*, London, 1934, p. 192.

Convection Currents in an Unstable Layer of Fluid studied by Optical Methods.

THE convection currents set up in a thin horizontal layer of a liquid by an unstable distribution of density have been studied experimentally by many investigators. Following Bénard, the usual method of making the movements visible is to mix with the liquid fine particles of some shining substances such as aluminium or "gold" paint. Simple optical methods enable the phenomena to be studied in much greater detail.

A horizontal layer of liquid is obtained by floating it on clean mercury. The surface of a volatile liquid like ether or alcohol cools rapidly by evaporation resulting in an unstable distribution of density. With less volatile liquids, instability can be produced by placing the tray of mercury on a flat heater. If we reflect the divergent beam of light coming from a point source of light at the mercury surface at nearly normal incidence and receive the reflected beam on a screen, a pattern is formed on the screen showing the local deviations of optical thickness of the evaporating layer. Bright points and lines correspond to convergence of beam (cooler liquid or increased thickness) and dark points and lines to divergence. The liquid behaves as a composite lens backed by a plane reflector.

Figs. 1 to 5 show the successive stages of the appearance of the pattern on the screen as a layer of ether floating on mercury gradually gets thinner. When the layer is more than 4 mm. thick, prominent dark canals and rapidly moving thin bright filaments make their appearance. The former are regions at which the liquid ascends. When the thickness is 2–3 mm., the bright filaments converge to a series of lines or points surrounded by the dark canals. As the film gets thinner, the movement becomes less brisk, the dark canals get narrower and the bright spots in the middle of the cells get more concentrated and become connected together by bright lines. After a certain stage, the dark lines become invisible, but

Fig. 1.
Ether; thickness c. 7 mm.

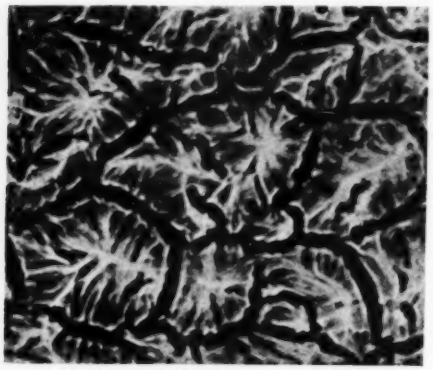


Fig. 2.
Ether, thickness c. 3 mm.

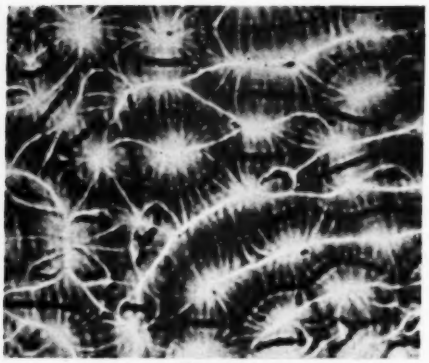


Fig. 3.
Ether; thickness c. 2 mm.

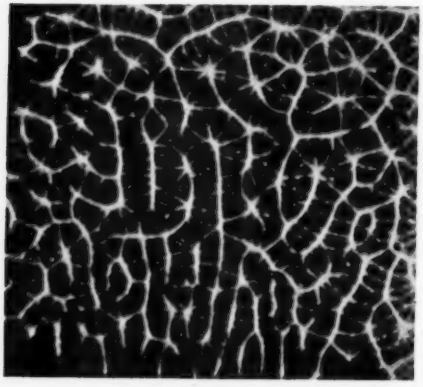


Fig. 4.
Ether; thickness c. 1 mm.

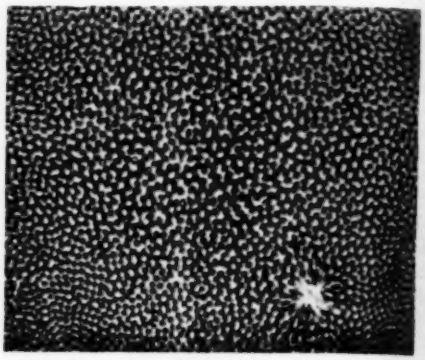


Fig. 5.
Ether; thickness c. 0·2 mm.

in this condition also, we have ascending movement in the middle of each bright-bordered cell and convergence and descending movement at the boundaries. A noteworthy feature of the vertical circulation in each individual cell is that the movement in the upper level is much more rapid than in the lower. This is easily verified by observation of floating specks of dust. As the film approaches the vanishing stage, the field is covered by a net-work of alternately bright and dark cells and just before vanishing, the film becomes continuous.

If instead of ether, we use a less volatile (and also more viscous) liquid like carbon tetrachloride, the movements are generally more sluggish but the sequence of changes is essentially the same; when the liquid layer is very thin, it divides itself into remarkably regular hexagons (Fig. 6). The regularity is

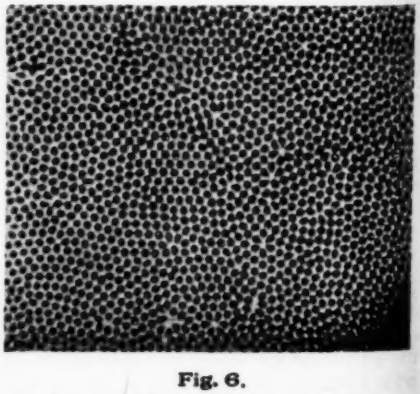


Fig. 6.
Carbon tetrachloride; thickness c. 0·2 mm.

dependent on a proper balance between density-gradient and viscosity.

If the unstable liquid has a translatory movement, the cells arrange themselves along the line of movement accompanied by characteristic changes of shape. Figs. 7 and 8 obtained with carbon tetrachloride

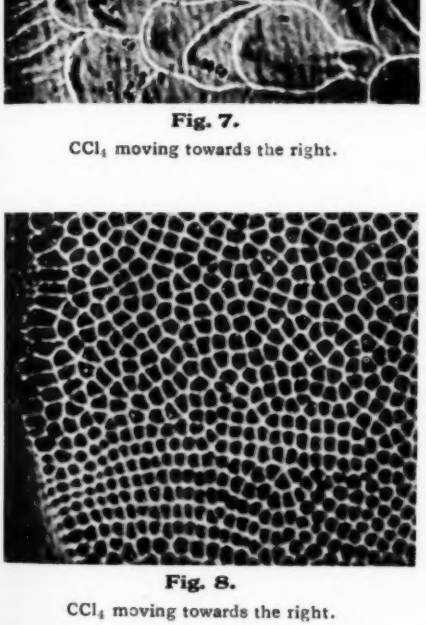


Fig. 7.

CCl_4 moving towards the right.

Fig. 8.

CCl_4 moving towards the right.

illustrate this. Their similarity to cloud forms has been studied by Mal, Walker, Phillips and others.

The influence of temperature-gradient, viscosity and heat-conditions of the liquid in determining the instability and the patterns of cell-structure is being investigated in the light of theories developed by Lord Rayleigh and H. Jeffreys. The Schlieren method can also be used to show up the cells, but the shadow method is simpler. Attempts are being made to apply these methods to study the vortices in gases.

K. R. RAMANATHAN.
V. N. KELKAR.

Poona,
April 4, 1935.

Induced Radio-Activity.

As a result of the neutron bombardment induced radio-activity by the liberation of β-particles has been examined in a large number of cases by Fermi and his collaborators.[1] These results are interesting as in almost all cases the active products were ascertained by chemical methods of separation and examination. According to Fermi's reactions elements of odd atomic and mass numbers are, in general, transmuted to radio-active elements with expulsion of α-particles and those of even atomic and mass numbers transmuted to similar active elements with expulsion of protons. The reactions can be represented by the following typical examples.

$$Al^{27}_{13} + n^1_0 = Na^{24}_{11} + \alpha \quad .. \quad (1)$$

$$Mg^{24}_{12} + n^1_0 = Na^{24}_{11} + p \quad .. \quad (2)$$

$$Na^{24}_{11}(\text{active}) \rightarrow Mg^{24}_{12} + \beta.$$

A second type of reactions by expulsion of protons in the cases of some of the elements of odd atomic and mass numbers is also given by Fermi thus :—

$$P^{31}_{15} + n^1_0 = Si^{31}_{14}(\text{active}) + p$$

$$Si^{31}_{14} \rightarrow P^{31}_{15} + \beta \quad .. \quad (3)$$

It may be interesting to point out here that this second type of reaction with liberation of protons is rather uncommon at least in the case of heavier odd numbered elements. Expulsion of protons from elements of light nuclei will also be shown to take place very seldom.

A third type of reaction in which neutrons are simply or directly captured within the nucleus of the bombarded atoms (without the expulsion of a proton or an α-particle) and thus forming a heavier and active isotope of the parent atom may also be possible. If the reaction of the third type be postulated for Na, it should be represented thus—

$$Na^{23}_{11} + n^1_0 = Na^{24}_{11}(\text{active}) \rightarrow Mg^{24}_{12} + \beta \quad .. \quad (4)$$

The active product Na^{24}_{11} having a decay period of about 15 hrs. has however been obtained only as a secondary product due

to the expulsion of a proton from Mg or by the expulsion of an α-particle from Al. Fermi has found that the activity in association with Na bombarded with neutron has only a period of 40 secs.—which is certainly in disagreement with the formation of Na_{11}^{24} from Na as postulated in (4). Bjerge and West-cott[2] have reported a very weak activity from Na, the period of which is about 10 hrs. This they attribute to the direct formation of Na_{11}^{24} in accordance with the above reaction (4)—which may not be true in view of the discrepancy of the observed period of decay. To supplement the above contention, it may be cited that the direct transformation of Al_{13}^{28} into Al_{13}^{27} (decay period 3 mins.) by simple neutron attachment is not observed, as none of the two radiations given out by bombarded Al corresponds to this period. Similarly P_{15}^{32} (decay period roughly 13 days) does not correspond to any of the radiations given out by P and thus the view that at least in the cases of Na, Al and P[3] bombarding neutrons may be simply embedded into the nucleus of their parent atoms seems untenable. The activity of Na observed by Bjerge and West-cott might possibly be due to a reaction product obtained by expulsion of a proton according to the second mode of reaction

$$Na_{11}^{23}+n_0^1=Na_{10}^{23}+p$$

In the case of F, Bjerge and West-cott (*loc. cit.*) have observed a decay period of about 40 secs. This agrees with the decay period of Na as noticed by Fermi. The reaction product in this case appears to be certainly due to the direct attachment of the neutron to F-nucleus as represented in F_9^{20}. Na and F thus probably give rise to the same radio-active element according to the following reactions:—

$$Na_{11}^{23}+n_0^1=F_9^{20}+\alpha \quad .. \quad .. \quad (1)$$

$$F_9^{20}+n_0^1=F_9^{20} \quad .. \quad .. \quad (4)$$

According to Fermi, Mg also gives a decay period of 40 secs. which if it exists is very likely also due to F_9^{20}. This leads one to think that under neutron bombardment Mg may also decompose successively by emitting a diplon and then an α-particle thus—

$$Mg_{12}^{24}+n_0^1=Na_{11}^{23}+D_2^1$$

$$Na_{11}^{23}+n_0^1=F_9^{20}+\alpha$$

Direct attachment of neutrons to the nucleus of the bombarded atom as a primary process seems however more frequent in the case of heavy elements

$$K_{19}^{39}+n_0^1=K_{19}^{40}\ (\text{unstable})\rightarrow Ca_{20}^{40}+\beta.$$

Hevesy, Pohl and Hosemann[4] by a partial separation of the K-isotopes observed that the natural radio-active product was associated with a heavier isotope of K whose mass according to the determination of Baxter was equal to 40. Fermi and others[5] observe that by bombarding K with neutrons a heavier active isotope of K having a decay period of 16 hrs. has only recently been obtained. Unstable isotopes of V(52), Mn(56), Cu(64), As(76), Br(80, 82), and Rb(86) are found to originate from their parent substances by such simple neutron captures. Probably such simple attachments of neutrons to the nuclei of the bombarded atoms in the cases of heavy elements is rather more common and on many occasions the only form of reaction possible.

Regarding the inactivity of N under neutron bombardment as observed by Fermi, it may be remarked that the simple or direct neutron capture to the nucleus of N(14) without the following expulsion of protons or α-particles is rather improbable though N(15) might be transformed into N(16)—this, however, certainly does not form a stable group even for the least appreciable time. N(16) has however been obtained from F as a secondary product having a period of about 9 secs. (compare the cases of Na, Al and P). A form of direct neutron capture to the nucleus of N(14) or of O(16) giving an intermediate and very transient product forming N(15) or O(17) which is then immediately disrupted with emission of α-rays has been postulated by Feather[6] and Harkins, Gans and Newson[7]. N(14) of even mass number will not probably emit α-rays according to Fermi; rather an expulsion of proton is to be expected. Kurie observed the photographic tracks in a Wilson's cloud chamber in a mixture of N and O which revealed expelled particles of smaller charge than that of an α-particle —the expelled particles according to him might be a proton, a Diplon, or a H_1^3. Kurie suggests expulsion of protons as the most probable. The product of such a reaction should be radio-active liberating β-rays which is also negatived by Fermi's observation.

C and O are reported by Fermi to be non-active under neutron bombardment; probably therefore no protons are expelled

from them. Most likely then there is truth in the other suggestion of Kurie that Diplons D_1^2 (as has been supposed to be expelled from Mg) are also given out from the nuclei of these light elements (N and O)—the reaction products in all these cases will however be stable and therefore will not radiate. Feather[6] is of opinion that during disintegration of N with neutron capture a Diplon is in fact expelled according to the reaction $N_7^{14}+n_0^1=C_6^{13}+D_1^2$.

S. C. BISWAS.

Physics Department,
Dacca University.
February 15, 1935.

[1] Fermi, Amaldi, Agostino, Rasetti and Segre, *Proc. Roy. Soc.* (A), 1934, **146**, 483.

[2] Bjerge and West-cott, *Nature*, Aug. 25, 1934, 286.

[3] Newmann and Walke, *Ibid.*, Oct. 6, 1934, 531.

[4] Hevesy, Pohl and Hosemann, *Ibid.*, Sept. 8, 1934, 377.

[5] Fermi, Amaldi, Agostino, Rasetti and Segre, *Ricera Scientifica*, Dec. 2, 1934.

[6] Feather, *Proc. Roy. Soc.* (A), 1932, **136**, 709; 1933, **142**, 689.

[7] Harkins, Gans and Newson, *Phys. Rev.*, 1933, **44**, 945.

[8] Kurie, *Phys. Rev.*, 1934, **45**, 904.

A note on the method of determining the heat of dissociation from a study of the long wavelength limit of the Continuous Absorption by gas molecules.

MY attention has been drawn to a letter by S. Datta and B. Chakrobarty in the *Current Science* of the February issue. Before dealing with their criticisms, I would like to point out that the potential energy curves drawn in Fig. 1 of their note are not correct for the ionic case. The potential energy curves for the normal and the first excited states of the ionic molecule should intersect and not join each other to make a common energy level of dissociation. This is apparent and has been stressed upon by Franck[1] himself on many occasions.

Datta and Chakrobarty have assumed that under the conditions of experiment at ordinary room temperature there would be an increase of the vibrational energy of the molecules with increase of pressure and as such the long wavelength limit would shift towards longer wavelength. They have obtained experimental results in accordance with this hypothesis. But this hypothesis, which is the mainstay of their note, falls to the ground for the following two reasons:—

(1) In the case of HCl as a particular example, this apparent shift of wavelength limit takes place as one goes on increasing the pressure of the gas upto 1 atmosphere, keeping the temperature and the length of the gas column constant. But the specific heat of HCl at constant volume is 5·00 at 20°C. and one atmospheric pressure.[2] This tells that under these conditions all the energy is due to translatory and rotatory degrees of freedom. A real shift of the long wavelength limit is not, therefore, expected when we increase the pressure from low values upto one atmospheric pressure.

(2) The increase of oscillation energy with increase of pressure is against the principles of thermodynamics, so long as the temperature remains constant. For, it can be easily shown that

$$\left(\frac{\partial v}{\partial p}\right)_\tau \quad \text{is} -\text{ve.}$$

in a gaseous system that obeys Van der Waal's law. The proof is as follows:—

we have $\left(\frac{\partial v}{\partial p}\right)_\tau = -\tau\left(\frac{\partial v}{\partial \tau}\right)_p - p\left(\frac{\partial v}{\partial p}\right)_\tau$

from the general principles of thermodynamics, but

$$\frac{\left(\frac{\partial v}{\partial \tau}\right)_p}{-\left(\frac{\partial v}{\partial p}\right)_\tau} = \left(\frac{\partial p}{\partial \tau}\right)_v, \text{ which is a positive}$$

quantity, say a.

Hence, $\left[\left(\frac{\partial v}{\partial p}\right)_\tau = \tau a\left(\frac{\partial v}{\partial p}\right)_\tau - p\left(\frac{\partial v}{\partial p}\right)_\tau\right]$

$$= \left[(\tau a - p)\left(\frac{\partial v}{\partial p}\right)_\tau\right]$$

Now $\left(\frac{\partial v}{\partial p}\right)_\tau$ is a negative quantity, and $\tau a - p$ is always positive for a system obeying Van der Waal's law. For,

$$\left[\tau a - p = \tau\left(\frac{\partial p}{\partial \tau}\right)_v - p = \frac{\tau R}{v-b} - p\right]$$

which is a positive quantity. Hence $\left(\frac{\partial v}{\partial p}\right)_\tau$ is negative. This means that for gases obeying Van der Waal's law, the total internal energy would diminish with increase of pressure the temperature remaining constant. As the oscillation energy steps are of a much higher order than the rotational energy values or the intermolecular potential energies,

there can be no increase of the oscillation energy value due to the increase of pressure.

The shift of the long wavelength limit with increase of pressure is thus only apparent as I have pointed out in my papers,[3] and this follows from considerations of the transition probabilities at different points in the upper curve, as shown by Trivedi[4] from wavemechanical considerations.

Moreover, the semiempirical criteria to define atomic and ionic molecules have since been modified along different lines.[5]

A. K. DUTTA.

Bose Institute,
Calcutta,
October 3, 1935.

[1] Franck and Kuhn, *Bull. U. P. Acad.*, 1933, **2**, 223.

[2] Saha and Srivastava, *Text-book of Heat*, p. 88.

[3] Dutta, *P. R. S.*, 1932, **84**, 138; *Z. f. P.*, 1932, **77**, 405.

[4] Trivedi, *U.P. Acad. Sci.*, 1934, **4**, 59.

[5] Franck, *loc. cit.*; Dutta and Deb, *Z.f. P.*, 1934, **93**, 127.

APPARENTLY there has been some misunderstanding. What we conceived was the possibility of an increase in the number of molecules in the higher levels due to an increase in the "population" of the molecules in the lower level with a rise in the pressure and not an increase in the number due to any change in the vibrational energy with pressure.

The specific heat data, *viz.*, $C_v = 5$ for HCl does not shut out the possibility of the existence of vibrating molecules. For, even if the rotational states are developed upto ten quantum numbers ($j = 10$)—as evinced from infra-red data—the contribution to specific heat data by the rotational motion would be 1·808. This contribution due to translational motion would come up to 4·786 and the figure never reaches the value 5 even if the rotational states are assumed to be developed in full *i.e.*, $j = \infty$. Thus there is some contribution due to oscillation and this is further confirmed by the fact that HCl gas at ordinary temperature shows vibration-rotation spectra in the near infra-red ($n = 0 \rightarrow 1$, $n = 0 \rightarrow 2$) and the zero state of vibration according to wavemechanics has an energy $= \frac{1}{2}h\nu$. Once admitting that there are vibrating molecules, their distribution to different states according to Boltzmann's law would follow automatically.

The trouble that has been taken to show that $\left(\frac{\partial v}{\partial p}\right)_T$ is negative—a result which is given in all Text-Books of Thermodynamics—is useless; for this merely tells of the diminution in the total internal energy of the molecules and is equal to $-\frac{a}{v^2}$, caused by the fact that the molecular attraction increases with an increase in pressure. From this nothing can be inferred definitely regarding the effect of pressure on the oscillation energy. Had this diminution in internal energy meant the diminution of oscillation energy, bands arising out of higher vibrational transitions would have been suppressed with an increase of pressure. As is well known to the Spectroscopists, this never happens; on the contrary, working at constant temperature higher pressure is necessary to get the bands corresponding to higher vibrational transitions, which again confirms the view we have expressed in our note, that with an increase in pressure higher vibrational states may be developed mainly due to an increase in the "population".

The main point in our note, however, was not this theoretical issue but the *experimental fact that the curves showing the relation between percentage of absorption and wavelength in the cases of HCl, HBr* and N_2O *tend to zero values of the percentages of absorption at values of wavelengths which are different for different pressures and not for the same value of the wavelength as observed by Dr. Dutta.*

We agree with Dr. Dutta that these semi-empirical criteria to distinguish the Atomic from the Ionic molecules are not very satisfactory. With regard to the potential curves Dr. Dutta is right; it should be stretched slightly upward so as to intersect at least one of the upper curves.

P. DUTTA.

Presidency College,
Calcutta.

Note on the Statistical Theory of Regular Solutions.

IN a recent note[1] a statistical theory of solutions was proposed, but in a subsequent paper[2] it was observed that this theory as well as that due to Guggenheim[3] suffers from the defect that gas laws have been tacitly assumed. Recently Guggenheim[4] has extended his theory to the case of regular solutions as defined by Hildebrand[5] and others. We propose to develop the theory in a straightforward and simple manner.

As suggested before[6] we assume the following relation

$$dn = e^{\frac{\psi}{kT}} \mathrm{F} \Delta \tau$$

where ψ is the free energy, F the partition function, the form of which is not known, $\Delta\tau$ the elementary phase volume. Consider a mixture of n_A and n_B molecules of substances A and B forming a regular solution in which x molecules of each are present as A-B pairs. We then have

$$\psi_A = kT \ln (n_A - x) - \ln \int \mathrm{F} \Delta \tau$$
$$\psi_A' = kT \ln x - \ln \int \mathrm{F} \Delta \tau$$

where ψ_A and ψ_A' are the free energies of A molecule present as A-A pair and as a component of A-B pair respectively. Hence the change of free energy

$$\Delta \psi_A = \psi_A - \psi_A' = kT \ln \frac{n_A - x}{x}.$$

Similarly we have

$$\Delta \psi_B = kT \ln \frac{n_B - x}{x}.$$

Now the total change of free energy is equal to the increase of potential energy of the system

$$2 (2 w_{AB} - w_A - w_B)_r = 2\lambda/r$$

as defined by Guggenheim. r is the number of molecules surrounding each pair. Hence

$$\Delta \psi = kT \left(\ln \frac{(n_A - x)}{x} - \ln \frac{(n_B - x)}{x} \right) = 2\lambda/r$$

from which we have $\frac{(n_A - x)(n_B - x)}{x^2} = e^{2\lambda/rkT}$

which on transformation reduces to Guggenheim's relation. Hildebrand's relation follows as a special case for $\lambda = 0$, *i.e.*, when the total change of free energy is zero.

A. GANGULI.

Chemical Laboratory,
College Dupleix,
Chandernagore,
March 25, 1935.

[1] Ganguli, *Curr. Sci.*, 1933, **2**, 212.
[2] Ganguli, *Koll. Z.*, 1934, **67**, 304.
[3] Guggenheim, *Proc. Roy. Soc.*, 1932, **A135**, 181.
[4] Guggenheim, *Ibid.*, 1935, **148**, 304.
[5] Hildebrand and Wood, *J. Chem. Phys.*, 1933, **1**, 818.
[6] Ganguli, *loc. cit.*, ref. 2.

Special Radio Test Transmissions on 12th and 13th March 1935.

UNDER the auspices of the Union Radio Scientifique Internationale (URSI) and in continuation of the practice of the last two years, a frequency of 1 khz of high precision and stability obtained from the 1 khz standard tuning fork at the National Physical Laboratory in England was radiated in accordance with a previously notified schedule, as a modulation of the carrier frequencies of the broadcast transmitters, Droitwich (200 khz, 150 kw), Scottish Regional (804 khz, 50 kw) and Scottish National (1050 khz, 50 kw) of the British Broadcasting Corporation, England. These emissions took the form of a preliminary emission programme for adjustment purposes on 12th March between 0545 and 0615 IST; the main schedule of emissions of 13th March lasted from 0600 to 0845 IST. These emissions have the two-fold object (*a*) of intercomparison of national standards of frequencies or of calibration of local apparatus where primary standards do not exist; and (*b*) of making observations of a physical nature such as fading, etc., characteristic of the transmission path.

Recently, a multivibrator type of wavemeter equipment of up-to-date design and driven by a 1 khz elinvar tuning fork, maintained at a temperature varying little from 50°C and at a pressure of 75 mm. has been installed in the laboratories of the Department of Electrical Technology of the Indian Institute of Science, Bangalore, to serve as the reference standard for India. The frequency of this fork had been accurately measured at the National Physical Laboratory prior to shipment of the apparatus to India. But the measurement on 13th March of the frequency difference between the two 1 khz signals—either by the phonic wheel or by the beat note method—was found to be out of question on account of (*a*) the rapidly diminishing signal intensities at Bangalore of the incoming 804 and 1050 khz signals from early morning hours onwards, (*b*) fading and (*c*) atmospheric disturbances in relation to the signal strength. Comparatively speaking, the disturbances were far more severe on 200 khz, the frequency of Droitwich, and it was not without difficulty that the 1 khz modulating note could be heard. This station could not therefore be used.

For visual observations (Fig. 1), the output from each receiver was impressed across

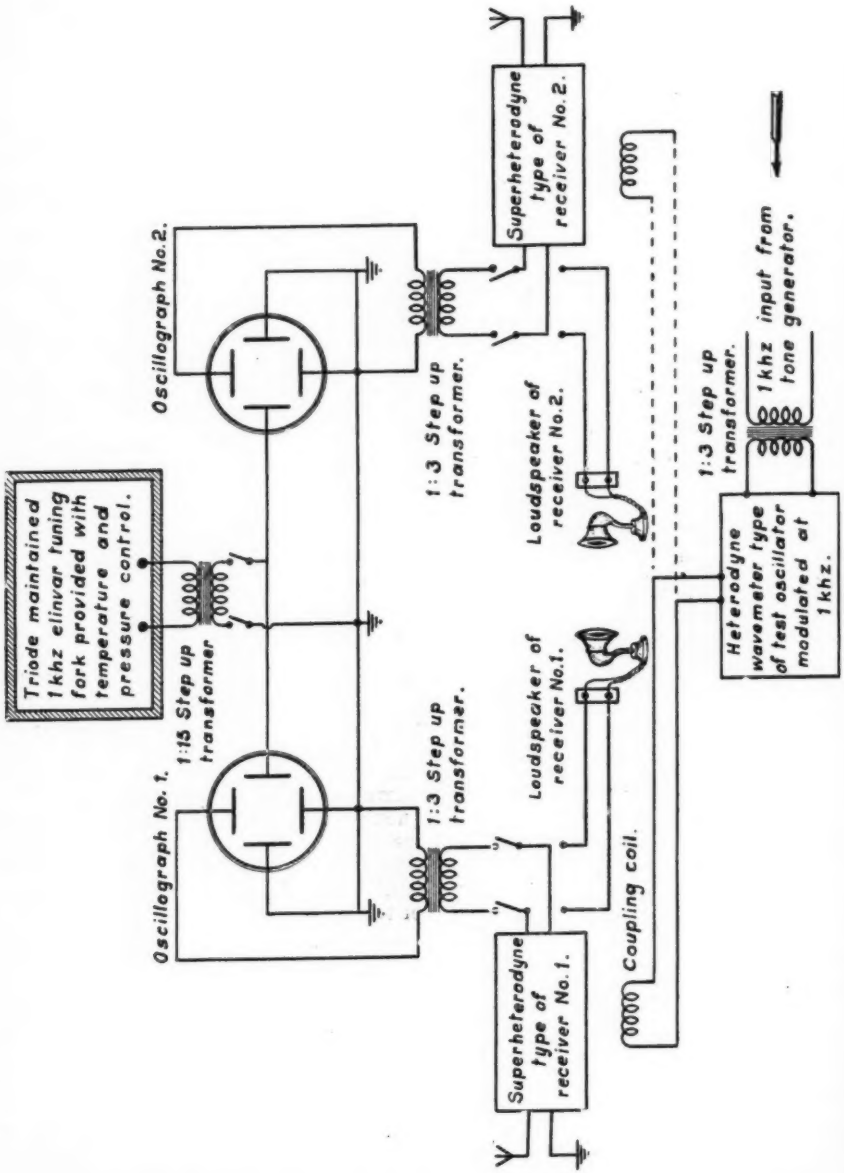

Triode maintained 1 khz elinvar tuning fork provided with temperature and pressure control.
1:15 Step up transformer
Oscillograph No. 1.
Oscillograph No. 2.
1:3 Step up transformer.
1:3 Step up transformer.
Loudspeaker of receiver No.1.
Loudspeaker of receiver No.2.
Superheterodyne type of receiver No.1.
Superheterodyne type of receiver No.2.
Coupling coil.
1:3 Step up transformer.
1 khz input from tone generator.
Heterodyne wavemeter type of test oscillator modulated at 1 khz.

Fig. 1.

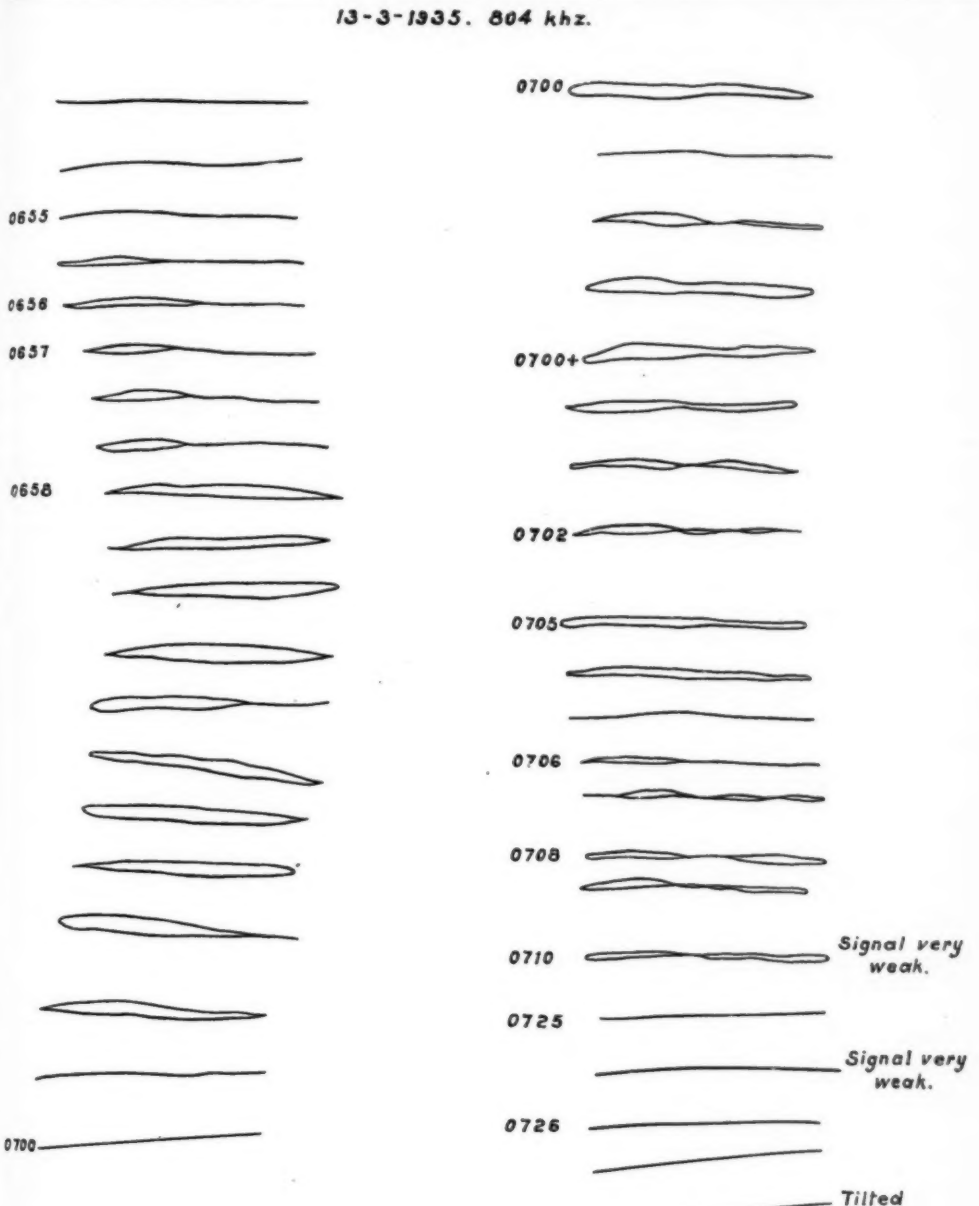

13-3-1935. 804 khz.
0655
0656
0657
0658
0700
0700
0700+
0702
0705
0706
0708
0710
Signal very weak.
0725
Signal very weak.
0726
Tilted

Fig. 2.

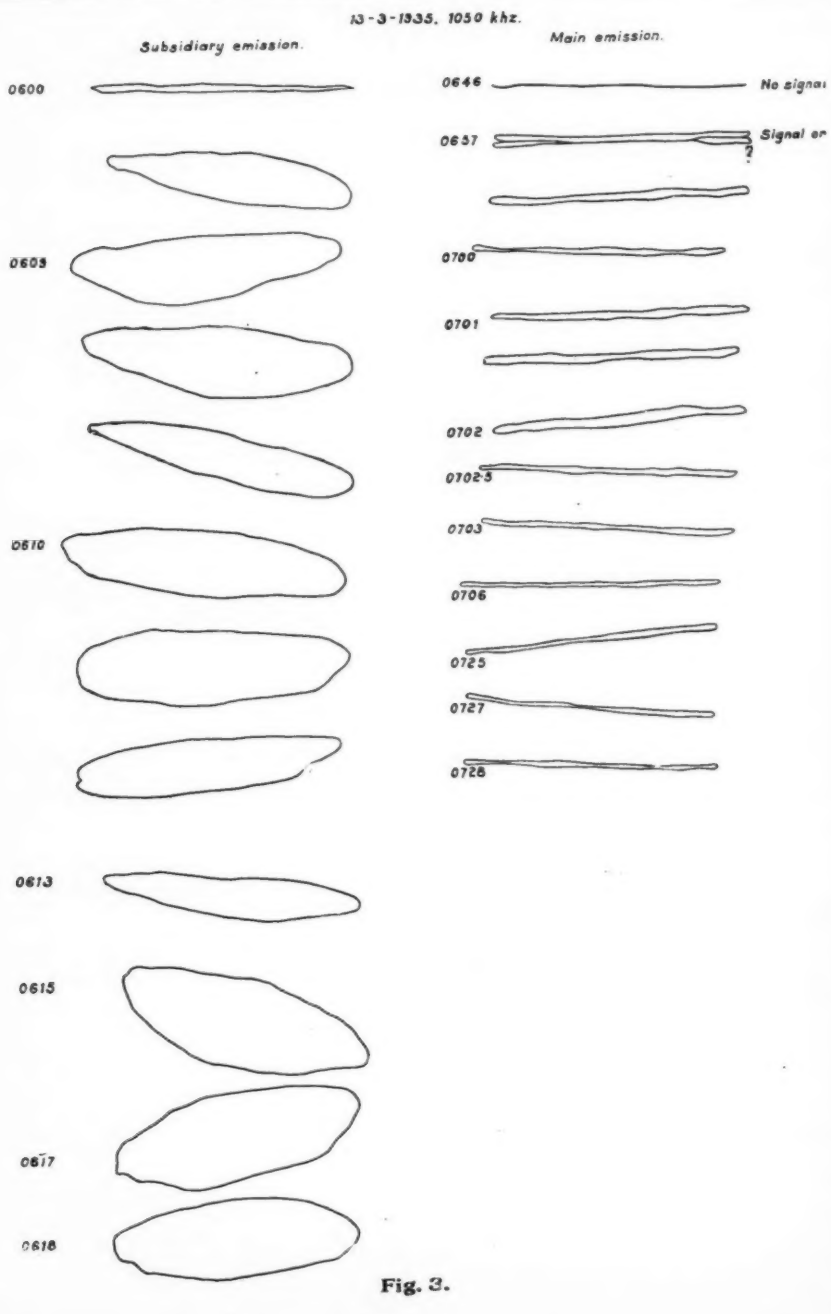

13-3-1935. 1050 khz.
Subsidiary emission.
Main emission.
0600
0605
0610
0613
0615
0617
0618
0646
No signal
0657
Signal or
?
0700
0701
0702
0702-5
0703
0706
0725
0727
0728

Fig. 3.

the vertical plates of its cathode ray oscillograph, while the horizontal plates were connected in common to the output of the local 1 khz fork apparatus; the resulting image on the screen was quickly traced by hand on a piece of clear tracing paper. Observations were hampered considerably by a rather unexpected source of trouble in the form of a continuous current motor used for pumping water. The announcements could not be made out at all.

The test oscillator modulated at 1 khz from a local tone generator was used in gaining experience in adjustment.

The pattern on the screen was, in general, a somewhat distorted ellipse on both 804 and 1050 khz; neither its shape nor its size was constant for more than a few seconds at either frequency (Figs. 2 and 3). The variations were more pronounced and rapid at the higher frequency than at the lower, particularly on 12th morning. In view of the location of the two transmitters at the same site in Scotland and the accuracy and high stability of the frequencies of the Institute and the NPL forks, the above would indicate that the variations in the figures observed on the oscillograph screen were due to the ionospheric transmission path in respect of intensity and of phase, that is, path difference. The local 1 khz voltage across the horizontal plates of the oscillograph with the 1050 khz receiver output across its vertical plates was replaced by the output from the 804 khz receiver; but the signals were so feeble that no clear diagram was obtained on the screen. The modulating frequency for the subsidiary emissions earlier in the morning on 13th March differed from that of the main emissions by only a few points in a million or less.

In spite of the distance of Bangalore from the transmitters and of the severity of electrical disturbances, more satisfactory observations and even measurements would probably have been possible if the programme of transmission had started about an hour earlier. Alternatively, modulation of some of the short wave transmitters might have enabled useful observations notwithstanding severe fading at these hours.

At the southern end of Bangalore, about 4 miles from the Institute Mr. N. Srinivasa Row "listened in" on 1050 khz using the excellent super heterodyne receiver owned by Sir M. N. Krishna Row. Atmospheric disturbances and fading were present but little of any "man made" disturbances. The announcements could be made out but somewhat incompletely. The 1 khz emission was heard; but as the morning proceeded, the signal got weaker; after about 0730 IST, nothing came out of the receiver except disturbances.

Grateful thanks are due to Dr. E. H. Rayner of the National Physical Laboratory, Teddington and present Chairman, Commission 1, Standards, of the URSI for kindly forwarding all relevant information and literature relating to the transmissions and to apparatus arrangements; to Mr. Evans of the Gramophone Company and to Mr. K. S. Ramamurthy for kindly lending the necessary broadcast receivers for the tests; and to Mr. N. Srinivasa Row for his accurate report of what he heard.

The apparatus arrangements and the observations were all made by Messrs. B. V. Baliga, T. D. Chatterji, T. Krishnaswamy Rao, S. N. Mukerji, K. Raghunatha Rao and T. V. Rama Murthy of the Electrical Communication Engineering Section of the Department of Electrical Technology of the Indian Institute of Science, Bangalore.

Indian Institute of Science,
Bangalore,
March 15, 1935.

Densities of Aqueous Solutions of Formaldehyde between 20° and 40°.

AUERBACH AND BARSCHALL[1] have determined the densities of formaldehyde solutions in water at 18°. As these solutions of different concentrations are now extensively used in photography in India, their densities have now been determined at temperatures between 20–40°. Thus, with the aid of an accurate hydrometer, the data given in Table I can be readily employed for determining the concentration of a given solution of formaldehyde at the usual laboratory temperatures in India.

For these determinations pure formaldehyde gas was obtained by passing a current of pure nitrogen over trioxymethylene contained in a retort heated to 180°. The gas was absorbed in distilled water kept in an ice bath and the most concentrated solution containing 42 per cent. of formaldehyde by volume was obtained. The amount of formaldehyde in the solution was estimated by the usual iodine method.

Densities were determined by a specific gravity bottle (Regnault type) which was

kept for fifteen minutes in a thermostat maintained at any desired temperature to within ± 0·02°. The balance weighed correctly to 0·1 mgm. and the method of double weighing was employed, correction being applied for bouyancy. A set of standard weights with N. P. L. certificate was used.

The results obtained are shown in Table I.

TABLE I.

Densities of aqueous solutions of formaldehyde in terms of the density of water at 4° C.

Grams of formaldehyde in 100 c.c. sol.	D_{20}	D_{25}	D_{30}	D_{35}	D_{40}
2·76	1·0065	1·0054	1·0037	1·0020	1·0001
6·3	1·0167	1·0152	1·0136	1·0115	1·0097
11·55	1·0320	1·0303	1·0284	1·0263	1·0242
14·43	1·0403	1·0385	1·0365	1·0344	1·0321
19·3	1·0552	1·0531	1·0510	1·0486	1·0462
25·26	1·0703	1·0681	1·0658	1·0633	1·0606
30·9	1·0859	1·0835	1·0808	1·0782	1·0754
37·35	1·1013	1·0987	1·0961	1·0933	1·0904
41·43	1·1126	1·1099	1·1071	1·1042	1·1019

Gujerat College, S. N. DATAR.
Ahmedabad,
February 26th, 1935.

[1] Arbeaten aus dem Kaiserlichen Gerandheit samte.—*Zweiundzwanzigster Band*, 1905.

Culture of Micro-Organisms on Cellophane Membrane.

IN the course of our studies on the mechanism of nitrogen fixation, it was found necessary to obtain considerable quantities of bacterial (azotobacter) growth free from the solid constituents of the culture media. By covering the solid medium with cellophane membrane, it was thought that the crystalloidal constituents comprising the greater portion of the nutriment, would permeate through the membrane and be made continually available to the growth of the bacterium while the solid medium underneath would, as usual, serve as the reservoir of nutrients and water.

The experimental technique consisted in covering the surface of the solid medium (after setting in a petri-dish) with a sterile strip of moistened Cellophane, so that the membrane was in intimate contact with the surface of the medium. (Cellophane supplied by the British Cellophane Company is used and it could be sterilised by heating it in an autoclave at 15 lbs. pressure for 15 minutes). The dish was inoculated in the usual manner. The organisms grew quite well on the media and the growth was found practically as satisfactory as the growth on plain, uncovered media. When sufficient growth had occurred, the membrane was lifted out of the dish and the bacterial growth easily recovered from the membrane.

The technique has now been successfully extended to other ærobic organisms. Attempts are also being made to apply the method to strict anærobes and to such parasites as normally grow only in association with their hosts.

T. R. BHASKARAN.
M. SREENIVASAYA.
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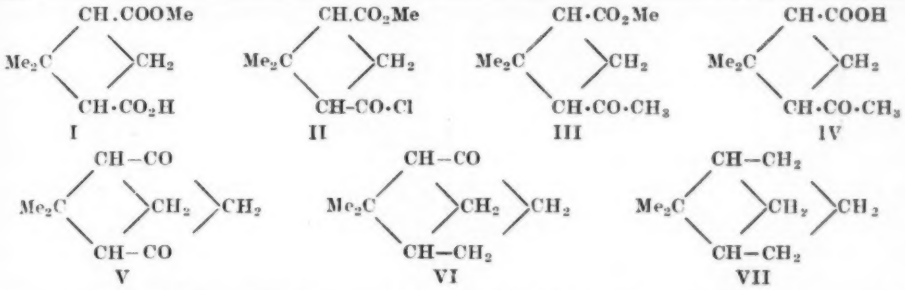
Indian Institute of Science,
Bangalore.
March 9th, 1935.

Synthesis of Pinononic Acid.

PINONONIC acid was obtained for the first time by Wagner and Ertschikowski[1] by the oxidation of *α*-pinene which contained some verbenone or verbenol, and later on Kerschbaum[2] and Blumann and Zeitschel[3] got the same by oxidising verbenone. Fromm and Autin[4] obtained the same acid by the oxidation of olibanol the constitution of which is not yet definitely known. The establishment of the constitution of verbenone, depends entirely on the synthesis of pinononic acid. This has now been achieved in the course of our attempts to synthesise pinene and verbenone starting from norpinic acid.

trans-Norpinic acid prepared according to the method of Kerr[5] with slight modifications, was converted into the *cis*-anhydride in an yield of 80-85 per cent. of theory by heating it with acetic anhydride in a sealed tube at 190-200°. This on being treated with an equimolecular quantity of sodium methoxide in methyl alcohol gave the sodium derivative of *cis*-norpinic acid monomethyl ester (I) in almost quantitative yield.



The acid chloride (II) prepared from the mono-acid (I) with thionyl chloride, gave on treatment with one molecule of zinc-methyl-iodide, pinononic acid methyl ester (III) b.p. 130-135°/14 mm. obtained previously by Wagner and Ertschikowski[6] by esterifying the acid obtained from pinene by oxidation. This ester has been hydrolysed by alcoholic potash to pinononic acid (IV) m.p. 129°: semicarbazone, m.p. 209°.

Work on the conversion of methyl pinononate (III) into "ketonopinone" (V) by the elimination of a molecule of methyl alcohol is in progress which it is expected on reduction will yield nopinone (VI) and nopinane (VII).

P. C. GUHA.
K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
April 2, 1935.

[1] *Ber.*, 1896, **29**, 881.
[2] *Ber.*, 1900, **33**, 890.
[3] *Ber.*, 1913, **46**, 1194.
[4] *Ann.*, 1913, **401**, 256.
[5] *J. Am. Chem. Soc.*, 1929, **51**, 614.
[6] *Loc. cit.*

Aerial Roots in Sorghum.

THE grain sorghum plant is usually single headed. When the head develops and gets weighty the plant supports itself on roots formed from the nodes immediately above the ground. Nodes up to four may usually function in such effective root production, though occasionally (according to vigour and closeness of the internodes) the number might go up to even ten. With the setting of the grains and the drying up or falling off of the lower leaves, ærial roots appear. In some cases such roots pierce through the persistent leaf sheaths. Their emergence is marked by knobs on the sheath surface. To determine the effect of the leaf sheath in such root formation 50 plants in the local Peria Manjal variety of sorghum were de-sheathed when 50 days old, with 50 other plants for a control. Observations on the emergence and distribution of ærial roots were made at intervals. Five days after de-sheathing 39 plants so de-sheathed started to develop roots, whereas only 4 in the sheaths-intact group showed such activity. After a month, in the 50 plants of the sheaths-intact group, 4 plants developed no ærial roots, 30 developed them in the first node above the ground, 14 in the first two nodes, 1 in three nodes and 1 in four nodes. In the de-sheathed group all developed roots, 11 of them in two nodes, 32 in three nodes and 7 in four nodes (*vide* Fig. 1). The

Fig. 1.

top nodes got stimulated consequent on de-sheathing, a condition brought about in nature through a natural slackening of the grip of the leaf sheath on the node and the need of the top-heavy plant for ancillary support.

Though the grain sorghums do not tiller like other cereals, still in certain years of abnormal rainfall and untimely opulence, there is a tendency for some of the dormant buds in the axils to give out side shoots that develop small ear-heads. The angle that these ear-heads make with the main stem coupled with the slackening of the hold of the leaf sheath, often results in the basal internodes of the side shoots being

Fig. 2.
Clasping roots of side shoot.

stimulated into root production. These roots develop rapidly and clasp the stem and thus afford security to the side shoots (*vide* Fig. 2). This close clasp is made efficient by the marked flattening of such clasping roots.

G. N. RANGASWAMI AYYANGAR.
V. PANDURANGA RAO.

Millets Breeding Station,
Coimbatore,
March 14, 1935.

Occurrence of *Psilotum*, Sw. in the Punjab.

THE genus *Psilotum*, Sw. is a very widely distributed one but is confined mostly to the tropical parts of the world.[1] There are only two of its species recorded. One is *Psilotum complanatum* Sw. and the other is *Psilotum triquetrum* Sw. The former species has not so far been observed in India. The latter is generally considered to occur mostly in Assam and Bengal. The two fairly old accounts of Prain[2] and Dalgado[3] and a private information from Royal Botanic Gardens, Calcutta, however, prove that the occurrence of the plant in this country is not so restricted. Specimens have also been collected from places in Southern India, Central Provinces, Bombay, United Provinces, etc. It would be of some further interest to point out that the distribution of this plant even extends to the Punjab—a region fairly removed from the tropics. According to the authorities of the Herbarium, Forest Research Institute, Dehra Dun, specimens of *P. triquetrum* have been collected and brought there from Upper Bashahr (a valley in Western Himalayas) besides from places in areas already mentioned. In the summer of 1933, the writer, who accompanied the late Rai Bahadur Dr. S. R. Kashyap on a botanical excursion to Himalayas, came across a few plants of *P. triquetrum* at Sultanpur, a place in Kulu which is another valley near Bashahr. The plants grew on the ground among the thick and moist undergrowth of *Alnus* forest along the bank of the river Beas. Some more plants of the species were found by Mr. S. A. Chaudhuri, another member of the party, from about two miles away from the previous place, growing in a similar situation. No more specimens were met with by the party at any other place in the valley.

The writer's thanks are due to Mr. K. P. Biswas of Royal Botanic Gardens, Calcutta, and Dr. K. Bagchee of Forest Research Institute, Dehra Dun, for the information supplied in the present connection.

PRAKASH CHANDRA JOSHI.
Department of Botany,
University of the Punjab,
Lahore,
March 13, 1935.

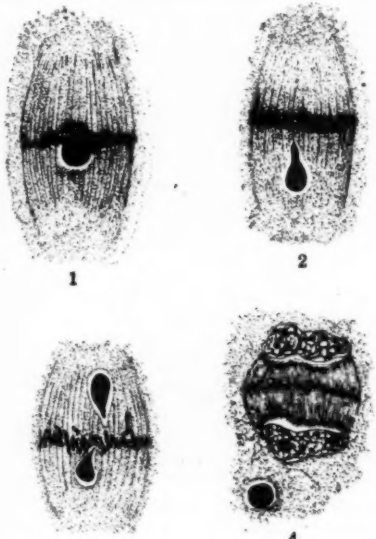
[1] Baker, J. G., *Fern Allies*, 1887, **30**.
[2] Prain, D., "The Genus *Psilotum*, Sw. in India," *Journal Bombay Natural History Society*, 1893, **8**, 428.
[3] Dalgado, D. G., "Note on *Psilotum triquetrum*," *Journal Bombay Natural History Society*, 1892, **7**, 544.

Nucleolar Behaviour in the Somatic Mitosis of *Trichosanthes dioica* Roxb.

FREW AND BOWEN[1] working on a number of Cucurbitaceous plants observed that during somatic mitosis the nucleolus often persists up to the metaphase when it divides and the divisional products migrate to the poles. Similar behaviour of the nucleolus in higher plants has been previously noted by other investigators an account of which has been given by Frew and Bowen. In this note an account of the behaviour of the nucleolus as observed by us during somatic mitosis has been presented.

Simultaneously with the disappearance of the nuclear membrane the nucleolus is also lost sight of, but in some cases it is seen to persist up to telophase. Such nucleolus is generally found to lie entangled within the chromosomes after the disappearance of the nuclear membrane. The volume of the nucleolus becomes much reduced. The nucleolus is usually round at this stage.

At the time of orientation of the chromosomes at metaphase the nucleolus also moves along with them and lies more or less



× 2,000

at the centre of the spindle (Fig. 1). Very soon after its orientation at the central region of the spindle, the nucleolus tries to move bodily to one of the poles and assumes different forms. This is noted before the anaphasic separation of the chromosomes. As the nucleolus moves further away from the chromosomes a very thin thread-like process may be seen connecting the nucleolus with the chromosomal region of the spindle (Fig. 2). During the migration of the nucleolus to the pole it appears as pear-shaped body which gradually rounds off and becomes spherical. In almost every case the nucleolus seems to move to either of the poles without division, but in a very few instances, however, division and subsequent migration of the divisional products have been noted. In these cases the nucleolus is caught just in the central region of the spindle at metaphase and becomes elongated in the direction parallel to its longitudinal axis and undergoes constriction at the central region. Gradually the central region becomes attenuated and the two daughter halves are pulled apart. The connecting process ruptures and finally the two daughter nuclei separate. The separated halves are not always identical (Fig. 3). The nucleolus as it reaches the pole is ultimately cast out of the spindle area and lies at some distance from it.

The anaphasic movement of the chromosomes does not take place until the nucleolus has reached its final position. During anaphase and telophase the nucleolus is found to lie in the position already attained by it during the metaphase. It remains in the same position without showing any signs of degeneration up to the reconstruction of the daughter nuclei. In the daughter nuclei new definitive nucleoli are organised. These newly constructed nuclei do not appear to have any connection with the cast out nucleoli which always remains extra-nuclear (Fig. 4). Mostly the cast out nucleolus at this stage does not seem to show any appreciable change, but in some preparations a dull appearance is noted. Shortly after this the extruded nucleolus suddenly disappears in the cytoplasm without leaving any trace. The cytoplasm appears to be quite homogeneous and no trace of the nucleolus is seen.

The mode of division and the migration of the divisional products of the nucleolus has been explained in various ways. The theory of fibrillar contractility does not appear to explain the polar migration of the nucleolus because as previously pointed out by other investigators, the nucleolus does not show any fibre attachment and still it moves earlier than the chromosomes. The

"Stemm-theorie" also fails to explain the precocious migration of the nucleolus to the pole. Frew and Bowen are of opinion that "the spindle area represents a region in which are localised those forces of whatever kind which are responsible for the anaphasic movements." The equatorial orientation and subsequent division of the nucleolus is merely a necessary result of the more or less incidental catching of the nucleolus in the spindle region. On this hypothesis the migration of the nucleolus to one of the poles as observed by us in *Trichosanthes dioica* could be explained. In metaphase the nucleolus lies a little above or below the equatorial plate and as such the "forces" acting on the nucleolus being greater on one side than in the other, the nucleolus is bodily pushed aside and migrates to one of the poles. In those cases where the nucleolus lies in the centre of the equatorial plate the forces at work being equal on both sides of it, the nucleolus is divided equally into two.

I. BANERJI.
M. C. DAS.

Department of Botany,
Calcutta University,
February 20, 1935.

[1] Frew, E. P., and Bowen. R. H., *Quart. Jour. Micr. Sci*, 1930, pp. 197-210.

Chromosome Numbers in *Sesbania grandiflora* Pers.—The Agathi Plant.

Sesbania grandiflora, Pers. is a leguminous soft-wooded tree commonly grown to serve as a post, on to which betel vines are trained. Its leaves provide light shelter. In the early stages young twigs with leaves are cut and fed to cows. The tender leaves are consumed as greens. The tree grows to a height of about 20 feet and its grand flowers are about 10 cm. long.

The chromosomes in this legume were studied in two varieties: (1) the common pole variety about 15–20 feet high with white flowers about 10 cm. long, flowering at definite times, and (2) the short, early branching, red flowered variety about 7–8 feet high, with flowers about 8 cm. long, with frequent flowering.

Divisions were obtained in pollen mother cells in buds of about ½ cm. long and of pollen grains in buds of 2 cm. length. Aceto-carmine smears as well as permanent sections stained in Gentian-Violet-Iodine were examined. Counts in both pollen mother cells and pollen grains gave 7 (seven) as the haploid number. The chromosome numbers in both varieties were found to be the same. In the pollen grains the chromosomes were found to be larger than in the pollen mother cells.

The chromosome complement was found to be made up of 2 long, 2 medium and 3 small. In the two long ones chromosome was slightly longer than the other, so also in the two mediums (Fig. 1). A median

Fig. 1. ×3500

attachment constriction was found in the longer and a sub-median in the shorter of these chromosomes. All the shorts had median attachment constrictions. The segregation was normal and regular. In the pollen mother cells one of the long chromosomes was found to be sometimes retarded (Fig. 2).

Fig. 2. ×3100

Kawakami (1930) records 16 (sixteen) as the haploid number in *Sesbania aculeata*, Pers.

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Coimbatore,
March 28, 1935.

The Fish and Fisheries of the Punjab.

In your issue of December last a correspondent attacks a series of short articles entitled as above which appeared in the *Statesman* on October 28th, and November 4th and 11th, 1934.

He appears to be under the impression that the above articles were a criticism on the Department of Agriculture and the Fisheries Research Officer. Let me assure him, here and now, that there was no such intention on the writer's part. If criticism or attack there was, it was levelled at Government for adopting a "drift" policy in regard to what should be an important department, responsible for a vast food supply of the province.

The writer in *Current Science* is, I presume, himself a scientist and, as such, should pride himself on the meticulous accuracy to detail and observation of facts from which his deductions are made. Half truths should be anathema to him, and yet what do we find? He quotes extracts from the articles in question to show that the writer advocates the closing down of all research, and carefully omits the passages which lead to the suggestion and go to the root of the whole trouble, *viz.* :—*Stop playing with research and wasting public funds. If you cannot do otherwise than play, then stop it entirely.*

The following extracts speak for themselves. I give them in parallel columns :—

FROM *CURRENT SCIENCE*.	FROM THE *STATESMAN*.
"The correspondent of the *Statesman* suggests .....that the research work on fisheries in the Punjab should be closed down 'until such time as adequate funds are available to place it on a proper footing, with a pisciculturist from Europe or America at its head'. This is just the kind of advice a civilian administrator of a scientific department would, in a spirit of despair, tender to the Government when its financial resources might be temporarily dislocated; but the viewpoint of a scientist would precisely be the opposite."	"Can the proverbial two men and a boy, with a tank to play in, constitute the research of a vast subject like the fisheries of a province? That research is essential no one can deny, but why play at it?"
Again, "The advocacy of the policy of closing down research departments of Government industries such as is advocated by the correspondent of the *Statesman*....can only be accepted on the responsibility of placing the country in a state of perpetual dependence on foreign products."	*Again*, "If....research cannot be carried on in a business-like way, with a proper staff and facilities, it should be closed down altogether till better times. To continue to play with it is a useless expenditure of public funds...."
	Again, "It has already been said that research is absolutely essential if we are to get the best results, but research must be undertaken seriously and not played with. If this cannot be done it would be better to close it down entirely until such time as adequate funds are available to place it on a proper footing with a pisciculturist from Europe or America at its head."
2. "According to the correspondent of the *Statesman* "when a Research Officer was appointed in 1920 it was confidently hoped that the branch would develop, but 14 years have elapsed and except that he has access to a fine laboratory, research, as such, is no further advanced." The Research Officer alluded to is a young inexperienced graduate of the Punjab University and he was expected to work miracles without special training and necessary guidance by the head of the department."	2. A layman might be forgiven for asking how long a scientist remains "young and inexperienced"? The Officer in question took his M.Sc. (1st Class) in Zoology, in 1916 or 1917. He then spent a year or so in the Law College and was Professor of Zoology in the Aligarh College before joining the Fisheries Department nearly 15 years ago. For the last 2½ years he has had the advantage of working under two eminent scientists, the Government Entomologist and the Director of Agriculture. Under their "special training and necessary guidance" has fisheries research progressed one iota in that time?

I attach no blame to the Research Officer as it has been very much a case of a carpenter without tools, but I would again reiterate *do not play at research*.

Alluding to the introduction of trout in the hill streams the writer tells us that it is dangerous to try experiments in introducing exotic species. He says :—"Any interference by clumsy experiments is an act which few trained and experienced scientists would lightly undertake." He, however, omits to mention that the experiment was undertaken in waters in which only one indigenous species exists, and that one of small economic value. On the other hand has not the question of introducing trout into the Ravee River *at Madhopur* (where mahseer and other indigenous varieties abound), been recently mooted, and by scientists? The question was put to me by one in all seriousness. He may, of course, have been untrained and inexperienced.

In the articles in the *Statesman* the suggestion was made that the Research Section should remain under the Agricultural Department but that the Administrative

Branch should be placed under the Game Warden. The latter part of the suggestion found an echo at the recent All-India Conference for the Preservation of Wild Life.

To put the whole case in a nutshell. If the Director of Agriculture is to administer the whole Fisheries Department as well as his own he should be given the staff and the facilities with which to do it. To expect a busy man like him to give the requisite time to another department is to ask for the superhuman.

On the other hand if D.D.A.'s and E.A.D.A.'s are to wander about the riverain tracts doing the work of Fisheries Officers they must have a good deal more time on their hands than one imagines. If they have enough work of their own to keep them employed then they obviously cannot do justice to the fisheries, so why try?

"INTERESTED."

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It occurs to us that the Punjab Government which provides money for fishery research and maintains a research officer should have invited a Fishery expert—for instance the Director of Fisheries, Madras, or the Director of the Zoological Survey of India or his nominee,—to draw up a programme of work for the officer and to supervise it periodically, when the Government discovered that it could not obtain such assistance from the non-scientific head of the Fisheries Department. It is inevitable that research under these circumstances should drift into play: and most assuredly the remedy is not to "stop". Use all the available forces and material. Then ask for more. Fisheries research is both a field problem and laboratory work and in the initial stages, a great deal of work is capable of being accomplished even with moderate equipment provided there is adequate knowledge and generous enthusiasm for discovering and solving problems. Recently we have had an occasion to refer in these columns[2] to the progress made by a small Fisheries Department in the Bombay Presidency and it is very gratifying to learn that without the expert advice of pisciculturists from America or Europe, this Department has during the last two years achieved great progress in the fish trade in Bombay. In order to improve its fisheries, the Punjab Government should place the Fisheries Department under a local expert possessing the requisite qualifications for advising the Government on scientific and administrative problems and for guiding and controlling the research work of the officers.

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[1] *Curr. Sci.*, 1934, **3**, 227-231.
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"The phenomenon of fish falling from the clouds in the rainy season, however incredible it may appear, has been attested by such circumstantial evidence, that no reasonable doubt can be entertained of the fact. The first instance we see recorded is that of a fall which happened at the Nokulhutty Factory at Dacca, and another shower took place near the Surbundy Factory, Furreedpore, both in 1830. Since which several instances are noticed in the papers of later dates. This phenomenon is of easy explanation. The fishes, 8 or 10 inches in length, are swept up by whirlwinds from ponds and held suspended in the rain cloud until they are thrown down in showers. The curious part is, that the fishes are found on the ground alive and uninjured."

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It may be recalled that in my recent

Branch should be placed under the Game Warden. The latter part of the suggestion found an echo at the recent All-India Conference for the Preservation of Wild Life.

To put the whole case in a nutshell. If the Director of Agriculture is to administer the whole Fisheries Department as well as his own he should be given the staff and the facilities with which to do it. To expect a busy man like him to give the requisite time to another department is to ask for the superhuman.

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It may be recalled that in my recent

article reference was made to a popular Hindu belief in Bihar regarding the sucking up of water from the earth by one of Lord Indra's elephants with a view to show the frequency of waterspout formation in that area due to meteorological conditions. This mythological belief had nothing to do with the scientific investigation of the causes of the phenomenon by Dr. Sen and myself as misrepresented by a writer[4] in *Nature* of September 22, 1934 (p. 454).

SUNDER LAL HORA.

Zoological Survey of India,
Indian Museum, Calcutta,
March 22, 1935.

[1] Hora, S. L., "Rains of Fishes in India," *Journ. Asiat. Soc. Bengal.* (N. S.), 1933 (1934), **29**, 95-110.

[2] Carey, W. H., *The Good Old Days of Honorable John Company* (Calcutta 1907), **2**, 361.

[3] Princep, J., "Fall of Fish from the Sky," *Journ. Asiat. Soc. Bengal*, 1833, **2**, 650-652.

[4] Anon, 'Showers of Fish,' *Nature*, 1934, **134**, 454.

Panthachuk (Srinagar, Kashmir) Rhyolite.

IN an issue of *Current Science*[1] a rhyolite was described from the Panjal Trap formation in the neighbourhood of Srinagar. In a subsequent issue[2] W. D. West, on the basis of a communication from D. N. Wadia, has thrown doubt on the validity of the discovery. He states that this particular occurrence is ordinary Panjal Trap (*i.e.*, andesite or basalt) which has been silicified.

	Panthachuk Rock (S. G. 2·63)	Average by Daly[3]	Rhyolite from Yellowstone National Park[4]
SiO_2	73·59	72·77	75·34
TiO_2	0·35	0·29	....
Al_2O_3	10·94	13·33	12·51
Fe_2O_3	0·32	1·40	0·42
FeO	2·98	1·02	1·55
MnO	0·04	0·07	0·07
MgO	0·23	0·38	0·32
CaO	1·80	1·22	1·07
Na_2O	5·05	3·34	3·31
K_2O	3·81	4·58	4·17
H_2O	1·46	1·50	0·86
P_2O_5	....	0·10	....
SO_3	....	....	0·42
TOTAL	100·57		100·04

No reasons have, however, been given for this statement.

The petrographic description of the rock given in the previous note is sufficient to prove that the rock is a rhyolite and not a "silicified" trap. My friend Dr. V. S. Dubey has now kindly analysed a specimen of the rock. The results of the analysis are given above. For comparison the average of 102 analyses of rhyolites by Daly and the analysis of a rhyolite, closely approaching the Panthachuk rock in chemical composition, are also given. It is obvious that the data regarding the Panthachuk rock are capable of only one interpretation, namely, that the rock is a rhyloite. The remarks of D. N. Wadia as quoted by W. D. West have no facts to support them.

NORM OF THE PANTHACHUK ROCK.

Quartz 29·34, Orthoclase 22·80, Albite 34·58, Acmite 0·92, Na_2O, SiO_2 1·59, Diopside 7·74, Hypersthene 1·45, Ilmenite 0·61. Total 99·03.

K. K. MATHUR.

Geological Laboratory,
Benares Hindu University,
March 5, 1935.

[1] *Curr. Sci.*, 1933, **2**, 126.

[2] *Ibid.*, 1934, **3**, 234.

[3] *Igneous Rocks and the Depths of the Earth*, 1933, p. 9.

[4] J. E. Whitfield, *U. S. G. S. Monograph*, 32, p. 126.

I THINK that Prof. Mathur has misunderstood the intention of the footnote. The nature of the rock described by Prof. Mathur and Mr. S. N. Wakhaloo in their letter to *Current Science* was never in question. It was quite clear from their description that it was a rhyolite. What Mr. Wadia took exception to was the impression given in the letter that acid volcanic rocks were fairly common around Srinagar, whereas according to him many of these rocks which at a first glance look like acid volcanic rocks, are really silicified basic volcanic rocks. Consequently in my footnote I used the words "in the main". Mr. Wadia is not now in India, but I am sure he did not question the nature of the particular rock described by Prof. Mathur and Mr. Wakhaloo.

Although these rhyolites may be quantitatively unimportant, nevertheless their discovery is of much interest; and the analysis given by Dr. Dubey adds further interest.

W. D. WEST.

On the Development of the Neural Arch, rib-bearing process and the rib of the trunk vertebræ of a Perennibranchiata *Necturus maculatus.*

By Himadri Kumar Mookerjee and Suryya Kanta Das,
Department of Zoology, University of Calcutta.

ACCORDING to Gadow[1,2] the neural arches of the trunk vertebræ of Perennibranchiata are formed from the cartilaginous basidorsals of either side, which eventually meet at the mid-dorsal line to complete the neural arch. There is neither the supradorsal nor the neural spine. Subsequent authors like Schauinsland[3] corroborated the statement of Gadow. Fmelianoff[4] has recorded that in the mesenchyme stage, there is apart from basidorsals another aggregation of mesenchyme, which from its position and form reminds one very much of an arch. This additional aggregation is not retained long and soon disintegrates.

One of us[5] who worked on the development of the vertebral column of *Triton vulgaris* has stated that, corresponding to each vertebral centrum, the cartilaginous basidorsals are situated in the middle region and this cartilaginous arch is gradually deflected posteriorly. The cartilaginous basidorsals of either side do not meet at the mid-dorsal line to complete the arch, but there is a third piece which should be called supradorsal. Corresponding to the anterior and posterior portions of each vertebral centrum the spinal cord is enveloped by a connective tissue arch which is curved not like the cartilaginous arch but forms two perpendicular side-pillars with a third piece as a roof, the latter has two projections on either side to form the dorsal shelves in each vertebra. From the mid-dorsal roof of the anterior connective tissue arch there forms a big neural spine. These anterior and posterior connective tissue arches become osseous without passing through the stage of chondrification. The connective tissue arches are narrower than the cartilaginous arches which project more on the lateral sides. Mookerjee for the first time recorded that the cartilaginous arch except the supradorsal, degenerates. The degeneration does not take place in the basidorsal as a whole, but cartilaginous cells together with the inner perichondrial layer degenerate, leaving behind the outer perichondrial layer which is converted into bone. If one goes through a series of transverse sections of the entire length of a vertebra at different stages, before and after the degeneration, he will find difference in the thickness of the connective tissue arch and the cartilaginous arch. Before the degeneration of the cartilaginous basidorsals, the connective tissue arches are much thinner than the cartilaginous arches, but after the degeneration of the cartilaginous cells and the inner perichondrial layer of the basidorsal has taken place, the thickness of the outer perichondrial layer becomes thinner than even the connective tissue arches. The supradorsal element retains its cartilage and will eventually be converted into a huge mass of bone.

Mookerjee[6] in collaboration with Chatterjee has shown the existence of anterior and posterior connective tissue arches in case of *Ophicephalus stolatus.* The same sort of connective tissue arches have also been shown by Mookerjee[7] in collaboration with Mukherjee in the cervical vertebræ of *Chrysemys marginata.* There is no degeneration of basidorsals in the above two cases of reptiles.

In case of *Necturus maculatus* we got the same sort of anterior and posterior connective tissue arches, and in between the two, there forms the cartilaginous basidorsals of either side with the intervention of supradorsal at the mid-dorsal line. The shape of the anterior and the posterior connective tissue arches are unlike that of the *Triton vulgaris*; have the shape of curved arches like the cartilaginous arch. The striking difference with *Triton vulgaris* is that, instead of slightly smaller than the cartilaginous arch they are bigger and there is no projection to form the dorsal shelves. The partly degenerated cartilaginous arches are almost identical like that of *Triton vulgaris.* In the same way as in the case of *Triton vulgaris* one can see in a serial transverse sections through any trunk vertebra other than the first four, the following structures in the serial order :—the anterior connective tissue arch, the cartilaginous thick arch and the posterior connective tissue arch (Figs. 1–3). A stage older than this where there has been a degeneration, the anterior and the posterior connective tissue arches are thicker than the degenerated cartilaginous arch in which the remaining outer perichondrial layer of the basidorsals, looks comparatively

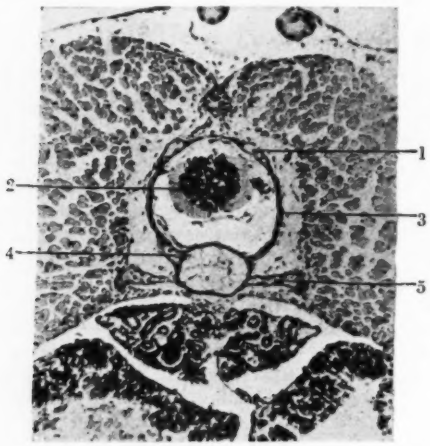


Fig. 1.

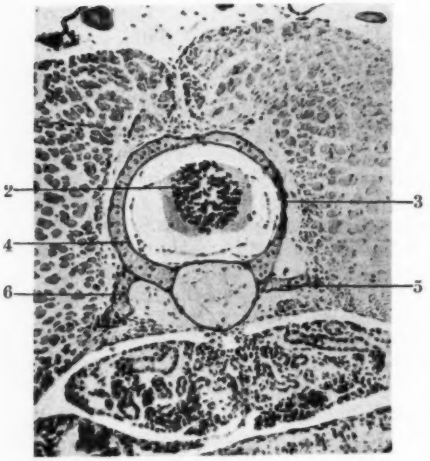


Fig. 2.

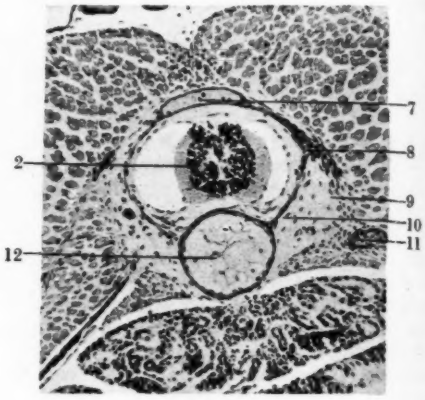


Fig. 3.

Figs. 1-3. Photomicrographs of serial transverse sections through different regions of a posterior trunk vertebra of *Necturus maculatus* at 38 mm. before the degeneration of basidorsal. × 37·3.

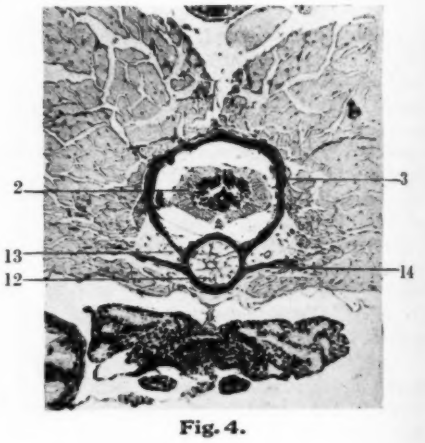
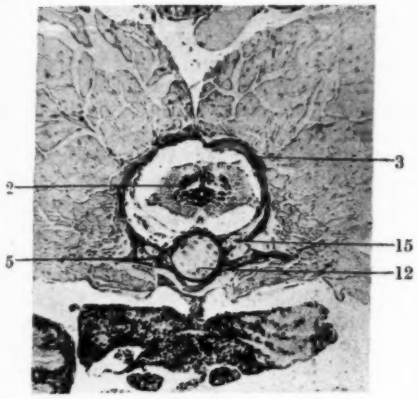


Fig. 4.

thinner than the connective tissue arches. These connective tissue arches together with the outer perichondrial layer of the cartilaginous basidorsals have now become osseous (Figs. 4–6). For the sake of comparison we have given the side view of three consecutive adult posterior trunk vertebræ (Fig. 7) and have marked those planes through which the transverse sections would have passed. Figs. 1–3 as one lot and Figs. 4–6 as another lot correspond more or less with the markings on the adult vertebræ.

Here we like to suggest that instead of calling the anterior and posterior connective tissue arches even after they become osseous it is better to call them the anterior and posterior membrane bone arches.

Regarding the rib-bearing process and the rib of *Necturus maculatus* it was Göppert[3] who suggested that there is hæmal arch element (basal stump) attached to the lateral sides of the centrum. Each of these from the middle of its length sends off a dorsal process which he called the rib-bearer. This passes dorsally to the neural arch and laterally to the vertebral artery and then



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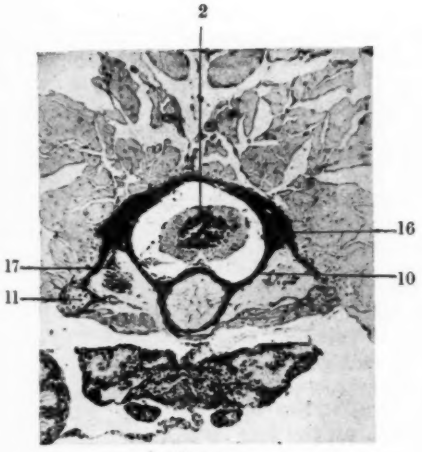

Fig. 6.

Figs. 4-6. Photomicrographs of serial transverse sections through different regions of a posterior trunk vertebra of *Necturus maculatus* at 48 mm. after the degeneration of basidorsal. × 37.3

continues dorsocaudally over the surface of the arch. The rib-bearer is separated from the cartilaginous arch by a connective tissue to start with, which ultimately becomes osseous. Further lateral to the rib-bearer the basal stump continues horizontally and the rib is a mere prolongation of this element. Still further lateral to this the rib is developed and a dorsal process of which extends towards the vertebra and becomes the dorsal head of the rib. This dorsal process is prolonged into a ligament which is attached by its other end to a mass of bony tissue

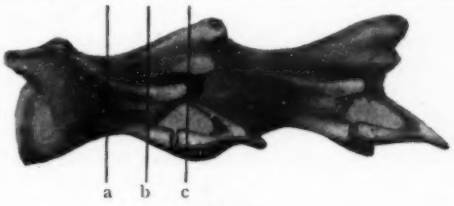

Fig. 7.

Side-view of two consecutive adult vertebræ of *Necturus maculatus*. × 2·6
a, *b*, *c* are the planes through which Figs. 1 to 3 and 4 to 6 have passed.

developed on the outer side of the rib-bearer (Fig. 8).

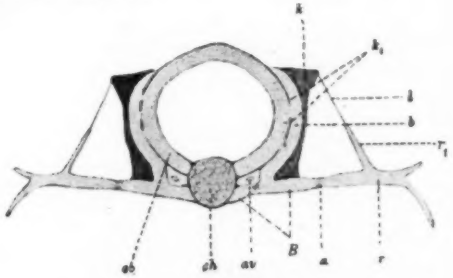

Fig. 8.

Transverse section through the trunk vertebra of *Necturus maculatus* at 43 mm. (after Göppert).
ch. Notochord; *ob*. Upper arch; *B*. Basal stump; *b*. Dorsal prolongation of the same; *r*. Rib; r_1. Dorsal rib process; *l*. Ligament connecting the same; *a*. Border between rib and basal stump; *k*. and k_1 Bony tissue; *av*. Vertebral artery.

According to Gamble[9] the mesenchymateous condition (which he calls as proton) of the rib and rib-bearer is made up of a larger number of cells which aggregate in contrast to the proton of parapophysis. The first cartilage to appear is the basal stump. Later the parapophysis is formed as a laterodorsal outgrowth. The first cartilage of the rib appears distally and later mesially. The first cartilage of the rib-bearer appears at the side of the neural arch. Later, this grows ventrally and fuses with the distal end of the parapophysis, and also develops dorsocaudally over the outer surface of the neural arch. The proximal end of the rib is relatively high in the second and third vertebræ, *i.e.*, it is on a level with the base of the neural arch. The parapophyses of the vertebræ in which the rib is high do not lie in a horizontal plane, but extend dorsolaterally and approach the rib-bearer.

The rib-bearer and the parapophyses do not fuse until relatively late, while the rib becomes attached to the rib-bearer before the rib-bearer and the parapophyses come together. In the second and third vertebræ the capitular as well as tubercular heads of the rib become attached to the corresponding processes of the rib-bearer. In these vertebræ the parapophysis takes no direct part in the formation of the rib attachment apparatus. Here the rib is an independent element from the standpoint of its origin and the connection with the basal stump is done at a later stage. In the trunk vertebræ the rib is on a level with the middle of the centrum. Here, the capitular head of the rib attaches to the parapophysis and the tubercular head makes no connection with any process of the rib-bearer. The rib-bearer fuses with the distal end of the parapophysis and as growth takes place the distal end of the parapophysis extends laterally past this point of union (Fig. 9).

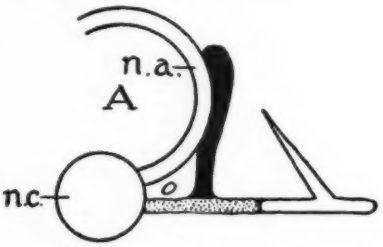

Fig. 9.

Transverse section through the trunk vertebra of *Necturus maculatus* (after Gamble).

A. Neural canal; *n.a.* Neural arch; *n.c.* Notochord.

Between the dorsal and ventral cartilaginous rods as well as the transverse processes and the two heads of the rib in the second and third vertebræ, procartilaginous cells persist which by proliferation bring about the elongation of the transverse processes. In the trunk vertebræ the head of the rib has no cartilaginous connection with the rib-bearer, so this provision just referred to is necessary only in the case of parapophysis.

Regarding the development of the rib-bearing process and the rib neither Göppert[8] nor Gamble[9] has given the correct statement. Both of them had no idea of the degeneration of basidorsal and the existence of the anterior and posterior membrane bone arches in each vertebra. Gamble[9] has given a figure (Fig. 24, page 558), in which he has faithfully represented the thin membrane bone arch but as he had no idea of its existence, so he could not identify it. In a trunk vertebra the first chondrification that take place regarding the rib and its associates is the basal stump which is on the lateral side of the centrum at the middle level (Fig. 1). Soon after this there forms another chondrification which starts from the outer side of the basidorsal almost at the base in a downward direction to meet the horizontal basal stump (Fig. 2). This downward piece of cartilage is the rib-bearing process or the diapophysis. The vertebral artery lies within the space enclosed by the rib-bearing process on the lateral side and the basal stump at the bottom very close to the centrum. Both Göppert[8] and Gamble[9] have stated and which have been represented in the figures given by them (Figs. 8–9) that the rib-bearing process is situated along the side of the basidorsal and it reaches at a considerable height towards the dorsal side. As a matter of fact in a trunk vertebra barring the first four, the rib-bearing process does not proceed along the side of the basidorsal towards the dorsal side. In the meantime another chondrification takes place at the free end of the basal stump. This is a rod-like structure representing the ventral fork of the rib (Fig. 3). At the anterior portion of the vertebra where there is the anterior connective tissue arch, connective tissue cells are aggregated at the lateral side of the centrum in the same level with the basal stump (Fig. 4). The same thing happens towards the posterior region of the vertebra. These two connective tissue aggregations on the two lateral sides of the basal stump are responsible for the formation of the horizontal wing-like thin osseous processes which Wilder[10] has drawn attention to in his description of the adult skeleton. The connective tissue aggregations in question become osseous without passing through the stage of chondrification as thin membrane bones. At the posterior portion of the vertebra where there forms the posterior connective tissue arch, another condensation of connective tissue takes place at the dorsolateral sides of the arch, at a higher level than the upper end of the rib-bearer (Fig. 3). From these condensations a thin band of connective tissue cells is projected ventrolateralwards in each case. This condensation of connective tissue cells at the dorsolateral sides of the posterior connective tissue arch in each vertebra becomes osseous

as membrane bone without passing through the stage of chondrification forming the diapophysis of the posterior membrane bone arch (Fig. 6). The projected ventrolateral bands of connective tissue articulates with the rod-like rib a little below the tip forming the dorsal fork of it (Fig. 6). So that the dorsal fork of the rib of the trunk vertebra other than the second to fourth is a membrane bone. One point that we shall like to point out that the connective tissue that articulates the membrane-bone-diapophysis with the cartilaginous rod of the rib, the whole of it is never converted into bone but only that portion of it becomes membrane bone which forms the dorsal fork of the rib. Between the dorsal membrane bone fork of the rib and the membrane bone diapophysis the connective tissue band becomes a ligament. At a later stage all the cartilaginous structures of the rib and its associates become osseous. Subsequently the space between the membrane bone diapophysis on the dorsal side and the osseous basal stump at the ventral side which was filled up by loose connective tissue also becomes a thin sheet of vertical membrane bone (Fig. 10),

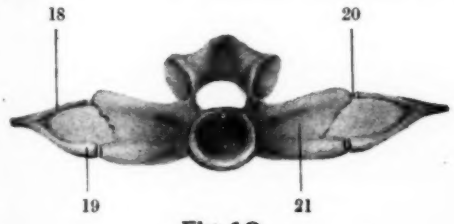

Fig. 10.

Posterior view of an adult posterior trunk vertebra of *Necturus maculatus*. × 2·7

which Wilder[10] in his description has referred to and which Gamble[9] has shown as merged in with the rib-bearing process. In the vertebræ from second to fourth the cartilaginous rib-bearer starts a little higher in level and it is formed along the side of the basidorsal (Fig. 11). In the meantime the cartilaginous basal stump goes upwards to meet the lower tip of the rib-bearing process. The vertebral artery lies within the curvature of the basal stump (Fig. 12). The rib-bearer sends side processes, one from the dorsal portion, a little downwards from the dorsal extremity and the other from the point of union of the rib-bearer and the basal stump. Really speaking the ventral projection is the prolongation of the basal stump. The rib has two forked processes which are articulated with the two dorsolateral projections just mentioned (Fig. 13). The ventral fork of the rib is the capitulum and the dorsal fork is the tuberculum. These two forks meet together to form the base of the rib. We like to point out here that Gamble[9] is wrong in saying that the rib is an independent structure and has nothing to do with the basal stump or parapophysis. As a matter of fact the basal stump articulates first with the rib-bearer and from the point of union the basal stump is prolonged as a lateral outgrowth. The posterior membrane bone arch has also the membrane bone diapophysis which can be found as a projection on

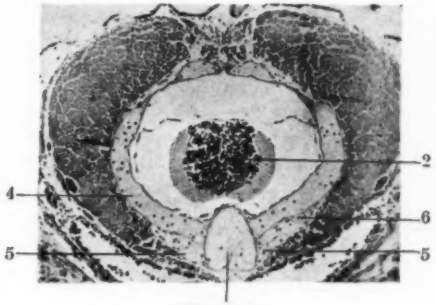

Fig. 11.

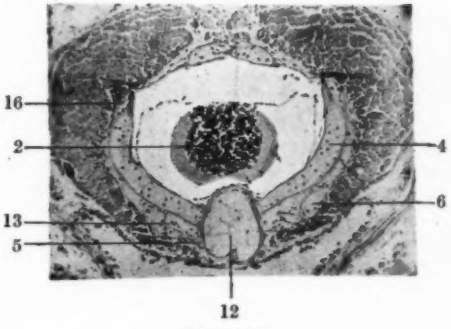

Fig. 12.

the top of the cartilaginous diapophysis. So in these vertebræ when ossification takes place the two forks of the bifid rib become stout rods of bone articulating with the two rods, one with the dorsal diapophysis and the other with the ventral parapophysis (Fig. 14). For the sake of comparison we have given the side view of the second, third and fourth vertebræ (Fig. 14) and have

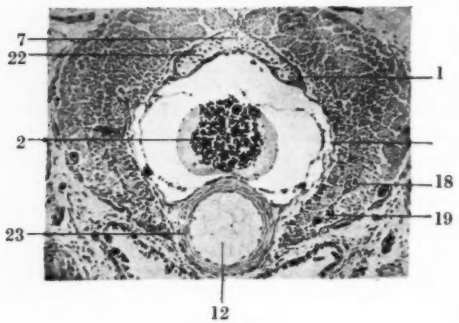

Fig. 13.

Figs. 11-13. Photomicrographs of serial tranverse sections through different regions of the anterior trunk (second) vertebra of *Necturus maculatus* at 38 mm. before the degeneration of basidorsal. × 31·5.

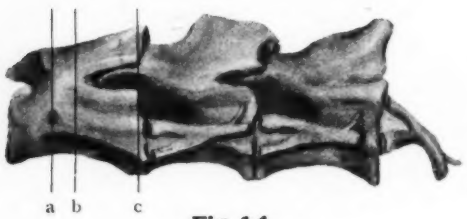

Fig. 14.

Side-view of the second, third and fourth trunk vertebræ of *Necturus maculatus*. × 2·4.
a, *b*, *c* are the planes through which Figs. 11 to 13 have passed.

marked those planes through which the transverse sections (Figs. 11–13) would have passed.

From the figures (Figs. 8–9) given by Göppert[8] and Gamble[9] one is inclined to think that both of them studied the anterior trunk vertebræ and tried to correlate with the adult posterior trunk vertebræ, otherwise they would not have mentioned that the rib-bearing process goes along the dorso-lateral side of the basidorsal. The statement of Göppert[8] is certainly better of the two workers when he has stated that there is an osseous element outside the rib-bearing process but Gamble[9] instead of advancing the idea has merged the membrane bone diapophysis along with the cartilage bone of the rib-bearing process.

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Numbering.

1. Prezygapophysis.
2. Spinal cord.
3. Anterior connective tissue arch.
4. Basidorsal.
5. Basal stump.
6. Rib-bearing process.
7. Supradorsal.
8. Thickening of the connective tissue cells for the formation of the membrane bone diapophysis.
9. Connective tissue band for the formation of the ligament.
10. Posterior connective tissue arch.
11. Rib.
12. Notochord.
13. Vertebral artery.
14. Membrane bone process for the formation of the horizontal wing of the centrum.
15. Degeneration of the cartilaginous cells and the inner perichondrial layer of the basidorsal.
16. Membrane bone diapophysis.
17. Connective tissue for the formation of the vertical membrane bone of the rib-bearing process.
18. Tuberculum.
19. Capitulum.
20. Ligament.
21. Vertical membrane bone of the rib-bearing process.
22. Post-zygapophysis.
23. Intervertebral connective tissue cells that have migrated inside to form the intervertebral ligament.

Report of the Minister of Agriculture for the Dominion of Canada for the year ended March 1933.

THE Canadian Ministry of Agriculture deals with a wide variety of agricultural activities covering every kind of agricultural interest which for comprehensiveness is not equalled by any other country. The record relates to the work of the Central Farm with its fourteen divisions, the work on the thirty Branch Farms and Stations and the departments of Dairy and Cold Storage, Health of Animals, Livestock, Seeds, Entomology, Fruits, Agricultural Economics and Publications. What a wide field is covered will perhaps be appreciated best when we point out that the Ministry controls even betting on race courses, a subject which one would hardly think of bringing within the ambit of agriculture. Details about the subject such as number of race meetings and racing days, amounts of money wagered, prize money, etc., are given with the same care and thoroughness as those relating, for instance, to manurial experiments, nutrition studies, releases of parasitic insects and the hundred other matters which one usually associates with a department of agriculture. This only shows in what an intimate manner the State concerns itself with the welfare of its foremost industry, investigating, directing, controlling and advising at almost every point. We may draw attention to another aspect of its work which marks it out as conspicuously different from what obtains in India, *viz.*, the extent of agricultural legislation and the administration of the numerous Acts passed thereunder. These deal with a variety of matters such as pest and weed control, guarantees of purity in seeds, fertilisers and feeds, disease control of livestock including bees, export and import control in respect of grades and standards of quality, packing, warehouse equipment, creamery, canning-house and elevator requirements and so on, a wide range of legislative control all calculated to advance the permanent interests of agriculture and the community though perhaps irksome and harassing to the individual. The Indian farmer is in the enjoyment of a blissful freedom in this respect—a freedom as blissful as that which permits smoking near a haystack. When one thinks of the prevalence of crop pests, contagious diseases of cattle and the confusion in the marketing methods in this country, one would welcome a powerful and liberal measure of reining in of this unholy freedom. The strict control methods have enabled the Dominion to benefit substantially by arrangements like the Ottawa Pact which, we are told, has materially increased the export trade in the United Kingdom.

We may now refer to some of the important items among the strictly agricultural activities of the department. One which is of timely interest in Mysore is the success which has attended what is called the biological method of insect control. The *Lecanium* scale is said to have been practically exterminated by this method, while against other important pests like the Oriental fruit moth, the satin moth, the green house white fly, the wheat stem saw fly and the corn borer, suitable parasites have been liberated with satisfactory results. We hope similar success will attend our own attempts in Mysore against the sugarcane borers. The increasingly large distribution of bacterial cultures of legumes is noteworthy in as much as it indicates that the true place of this method has at last been recognised, after the boom it once enjoyed and the disappointment it caused when the unduly high expectations were not realised. In the Division of Chemistry, experiments on pasture manuring and management confirm the now accepted conclusion that the stock carrying capacity is increased if the herbage is grazed quite young. The work relating to "quality" in produce such as protein and oil content in soyabeans, nicotine content of tobacco as related to "harshness" in smoking, is interesting and is worth being copied in India in regard to the chief products here. Manurial experiments bulk largely as usual in this Division; the results indicate the need for complete fertilisers including a suitable proportion of potash, an ingredient to which Indian soils have not always responded, at least as regards the *quantity* of produce. The Publicity and Extension Division maintains its high level as a model for propaganda methods. One of the happy features of this work is the intelligent response of the farmers themselves as evidenced by the co-operative experiments and the readiness with which questionnaires are answered. The various marketing and other surveys and studies of

the results of work are rendered easy and efficient by this attitude of the farming community and the report bears ample evidence of the advantages that have accrued thereby. The record of the year's work justifies the high reputation which the Canadian Department of Agriculture enjoys for the efficiency and diversity of its services.

A. K. Y.

The Indian Lac Industry.

TO an economically impoverished country like India, the preservation and expansion of its indigenous industries should be a matter of deep concern to the Government and to the large number of people who make their living in the industry. The Indian Lac Industry supports a large population of village tribes who cultivate lac, petty contractors who collect the raw material and a number of skilled labourers connected with the conversion of stick lac from forests into the shellac of commerce.

The entire bulk of this produce is exported away to Europe and America where the commodity enters into the manufacture of a variety of products. The continued prosperity of the Indian Lac Industry therefore is closely linked up with an expansion of its consuming industries and an extension of its uses based on industrial research.

The Government of India in pursuance of its policy of supporting indigenous industries levied a cess on the export of lac the proceeds of which have since been utilised for propaganda, marketing and research. The founding of a Lac Research Institute at Ranchi, the appointment of a Special Lac Enquiry Officer in London and more recently the deputation of three Indian Research Workers to England are the three landmarks in the scheme of stabilising the industry.

We have now before us a volume on "Lac and the Indian Lac Research Institute" by the three principal officers of the Lac Research Institute at Ranchi, during the last ten years of its existence. We have also been favoured with a copy of the technical paper on "Isolation of Pure Lac Resin", the first fruits of the Indian research workers under the auspices of the London Shellac Research Bureau.

The annual report of the Special Officer is an interesting document. In the first place, the work since its inception upto 31st March 1934 has cost the Indian Government Rs. 25,000: What is the return? one is entitled to ask.

The British manufacturers are evincing some interest in lac and the Special Lac Enquiry Officer has established and maintained fruitful connections with experts in Germany and America. He is also engaged in disseminating technical information regarding the uses of lac. He has also been doing great service to the Indian Lac Industry by organising exhibitions, writing articles on lac in important Journals and Year Books, pleading for a more extensive use of lac. Under the general advice and auspices of an Advisory Committee, the London Shellac Bureau is carrying out certain pieces of investigation relating to lac; so far, except for the fact that a few promising lines of inquiry have been initiated, nothing very striking or useful has yet come out of these endeavours.

What is most needed for the Indian Lac Industry is speeding up of research which means that all our resources, money, talent and laboratory facilities not only in Great Britain but also in India should be harnessed.

We should have a parallel Advisory Board in India who will arrange for certain pieces of work relating to lac to be conducted in Universities and Research Institutes who will gladly take up such problems. A move in this direction will speed up the progress of research on lac.

M. S.

Research Notes.

Metrical Problems of Continued-Fraction-Theory.

KHINTCHINE (*Comp. Math.*, **1**, 361-382) has analysed the general nature of the continued fraction development of an irrational number in a very interesting way,—*i.e.*, those properties which hold good for almost all numbers. Suppose α represents any number between 0 and 1; and let

$$\alpha = \frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3} + \cdots + \frac{1}{a_n} + \cdots$$

or

$$= [a_1, a_2, \cdots, a_n, \cdots]$$

say in any abridged form. Let $m_n(x)$ be the measure of the aggregate of values α for which $Z_n(\alpha) = [a_{n+1}, a_{n+2}, \ldots\ldots] < x \leqslant 1$; then it has been shewn by Gauss that $\underset{n \to \infty}{\text{Lt}}\ m_n(x) = \frac{\text{Log}(1+x)}{\text{Log } 2}$. This bit of Gauss's work was forgotten until Kuzmin [*Atti. del. Congr Intern. Bologna*, 1928, **6**, 83] gave a proof of the result and also extended it. Some more important results had been obtained by Bernstein and Borel; the chief result being—If $\phi(n)$ is an increasing function then the result $a_n = 0[\phi(n)]$ is true or false according as $\Sigma \frac{1}{\phi(n)}$ is convergent or divergent. (It is to be noted that a set of values whose measure is zero is always excluded.) Some more results were obtained by Khintchine himself during 1923–25. These results have now been extended and beautifully precised. After proving some lemmas he obtained a general result which is of great interest. The first lemma is this:—Let $\text{E}\binom{n_1, n_2, \cdots, n_k}{r_1, r_2, \cdots, r_k}$ be the measure of the aggregate of values α for which $a_{n_t} = r_t\ [t = 1, 2, 3 \ldots, \text{K}]$. If the n_t's are all different then we have

$$\frac{\text{E}\binom{n_1, n_2, \cdots n_{k+1}}{r_1, r_2, \cdots\cdots r}}{\text{E}\binom{n_1, n_2, \cdots, n_k}{r_1, r_2, \cdots, r_k}} < \frac{\text{C}}{r^2},$$

where C is an absolute constant. Now Gauss has shewn that

$$m_n(x) = \sum_{v=1}^{\infty}\left[m_{n-1}\left(\frac{1}{v}\right) - m_{n-1}\left(\frac{1}{v+x}\right)\right] \text{ and}$$

$$m'_n(x) = \sum_{v=1}^{\infty} \frac{m'_{n-1}\left(\frac{1}{v+x}\right)}{(v+x)^2}$$

By constructing similar functional equations and using a lemma of Kuzmin he generalises his earlier result into

$$\left| \frac{\text{E}\binom{n_1, n_2, \cdots, n_{k+1}}{r_1, r_2, \cdots\cdots r}}{\text{E}\binom{n_1, n_2, \cdots, n_k}{r_1\ r_2 \cdots\cdots r_k}} - \frac{\text{Log}\left[1 + \frac{1}{r(r+2)}\right]}{\text{Log } 2} \right| < Be^{-\beta\sqrt{n_{k+1} - n_k}}$$

where $n_1 < n_2 < \ldots\ldots < n_k < n_{k+1}$, and B and β being arbitrary constants. Utilising these results he proves the following important result:—Let $f(r)$ be a positive function of r such that $f(r) < kr^{1-\delta}$ where k and δ are two absolute positive constants. Then

$$\underset{n \to \infty}{\text{Lim}}\ \frac{1}{n} \sum_{k=1}^{n} f(a_k) = \sum_{r=1}^{\infty} f(r) \frac{\text{Log}\left[1 + \frac{1}{r(r+2)}\right]}{\text{Log } 2}$$

for almost all values of α. If we take $f(r) = \text{Log } r$ then we get the interesting result that

$$\underset{n \to \infty}{\text{Lt}}\ (a_1, a_2 \cdots, a_n)^{\frac{1}{n}} = \prod_{r=1}^{\infty}\left(1 + \frac{1}{r(r+2)}\right)^{\frac{\text{Log } r}{\text{Log } 2}} = 2.6 \cdot \ldots \text{ for almost all values of } \alpha.$$

It is of course obvious that we cannot obtain in a similar way a corresponding result for the arithmetic mean. The difficulty of this problem was already pointed out by Borel and Bernstein. By means of these methods alone the following result has been obtained:—

For every $\epsilon > 0$,

$$\text{E}\left\{\left|\frac{\text{S}_n \text{ log } 2}{n \text{ log } n} - 1\right| > \epsilon\right\} \to 0 \quad \text{as} \quad n \to \infty$$

where $\text{S}_n = \sum_{k=1}^{n} a_k$. This is not really equal to the result that $\frac{\text{S}_n}{n \text{ log } n} \to \frac{1}{\text{log } 2}$ for almost all α. In fact it is known that $\overline{\text{Lim}}\ \frac{\text{S}_n}{n \text{ log } n}$ is infinite. Another interesting result is that $\sum_{n=1}^{\infty} \text{S}_n^{-1}$ is divergent for almost all values of α.

K. V. I.

A Problem concerning Orthogonal Polynomials.

SZEGO (*Trans. Am. Math. Soc.*, **37**, 1, pp. 196-206) has proved certain interesting results in connection with the existence of two Jordan curves possessing a common system of orthogonal polynomials. Particular cases of such curves are (1) concentric circles for which $1, z, z^2, \ldots z^n, \ldots$ are the corresponding orthogonal polynomials with weight-function unity, and (2) confocal ellipses with foci at ± 1 for which the Tchebechef polynomials have the orthogonal property with weight-function $|1-z^2|^{-\frac{1}{2}}$. Although he has not solved the general problem he has obtained the following two results which forms a very decisive step in the solution of the general problem. The first theorem runs as follows:

Given two analytic Jordan curves C_1 and C_2 and two continuous positive functions $n_1(z)$ and $n_2(z)$ as the respective weight-functions and if they possess the same system of orthogonal polynomials then one curve say C_1 must contain the other C_2 and C_1 is a level curve obtained through the conformal transformation of the outer region (C_2) into the exterior of a circle, the point at ∞ being a fixed point; and there exists an analytic function $D(z)$ regular and $\neq 0$ outside C_2 ($z=\infty$ is to be considered as an inside point) such that—

$$\lim_{Z \to Z_0} \frac{|D(z)|^2}{|D(z)|^2} = n_1(z) \text{ for points on } C_1, \text{ and } = n_2(z_0) \text{ for } Z_0 \text{ on } C_2.$$

It is also easily seen that the method of proof applies for more general curves also. He has also determined all Jordan curves C and all analytic functions $D(z)$ regular and $\neq 0$ outside C which possess the property that if C_r be a level curve (the transformation being the same as in the previous theorem) then the set of orthogonal polynomials with weight-function $|D(z)|^2$ are independent of r. He has proved that there are only five essentially different cases (ignoring multiplication by means of a certain constant and linear transformation). He has also given short and elegant proofs of the orthogonality property in these particular cases.

Ratio of the Magnetic Moments of the Proton and the Deuton.

THE magnetic moments of the proton and the deuton have been determined by the molecular ray method by Stern and by Rabi, but there is some discrepancy between their results. The ratio of the magnetic moments of the two particles is not therefore known with certainty. Now L. Farkas and A. Farkas (*Nature*, 1935, **135**, 372) have calculated the ratio of the magnetic moments of the two particles in question by comparing the rates of the reactions

$$\text{ortho-}H_2 + O_2 \rightleftharpoons \text{para-}H_2 + O_2 \qquad (1)$$

and $$\text{ortho-}D_2 + O_2 \rightleftharpoons \text{para-}D_2 + O_2 \qquad (2)$$

The calculation is made according to the formula of Kalckar and Teller: $\left(\frac{\mu_H}{\mu_D}\right)^2 = \frac{a\, k_{H_2}^{(2T)}}{k_{D_2}^{(T)}}$

where a is a constant $= 1{\cdot}12$ for $T > 120°$ K. and $= 1{\cdot}18$ at $T = 83°$ K and $k_{H_2}^{(2T)}$ and $k_{D_2}^{(T)}$ are the velocity constants for the reaction (1) at 2T and for (2) at T. The values obtained are $\mu_H/\mu_D = 3{\cdot}85$, $4{\cdot}03$ and $4{\cdot}07$ respectively at 83°, 193° and 293° K. The variation is within the experimental error which is less than 5%.

T. S. S.

The Electronic Charge.

THERE is still an unsolved difficulty regarding the correct value of the charge on the electron. The oil-drop method of Millikan and its results have been discussed by Birge and yield the value $4{\cdot}768 \times 10^{-10} \pm 0{\cdot}005 \times 10^{-10}$ e.s.u. for the electronic charge. The value obtained by using the accepted structure and constants of calcite and the wavelengths of X-rays determined by means of a grating is much higher. Bäcklin has recently repeated his measurements with greater accuracy and arrives at a value $4{\cdot}805 \times 10^{-10}$ e.s.u. by this method. Now Schopper has determined e by finding the total charge carried by a counted number of α-particles and finds that $e = 4{\cdot}768 \times 10^{-10}$ e.s.u. in very good conformity with the oil-drop value. Birge and McMillan (*Phys. Rev.*, 1935, **47**, 320) have rediscussed the results of Schopper and come to the conclusion that $e = 4{\cdot}780 \times 10^{-10}$ e.s.u. This is 0·25% above the oil-drop value but is far lower than the value obtained from the grating measurements. A. E. Ruark (*Phys. Rev.*, 1935, **47**, 316) discusses the discrepancy between the crystal and ruled-grating wavelengths and shows that if Bäcklin's value $e = 4{\cdot}805 \times 10^{-10}$ e.s.u. (which is in very good agreement with Bearden's value

$4{\cdot}806\times10^{-10}\pm0{\cdot}003\times10^{-10}$) is used together with the value of $\frac{e}{m}=(1{\cdot}7579\pm0{\cdot}0003)\times10^{7}$ (e.m.u./g) obtained by Shane and Spedding, the discrepancy between the measured energy of photoelectrons and that calculated from X-ray wavelengths vanishes. This higher value of e leads to $1/\alpha=137{\cdot}04$ while Eddington's theory requires it to be 137. It thus seems as if the higher value for e is more satisfactory, but then the lower values obtained by the direct methods of Millikan and Schopper remain unexplained.

T. S. S.

Inter-molecular Compounds and Raman Spectra.

IT is well known that alcohol, ether, ketone and aldehyde molecules form addition complexes with inorganic acids and metallic halides, but regarding the nature of the complexes, whether they are valency compounds (quadrivalent oxygen, oxonium form), coordinative compounds (trivalent oxygen, onium form) or merely molecules held together by Van der Waal's, dipole, and such forces, only indefinite qualitative notions exist. Generalisations and analogy considerations are dangerous in this field of chemistry, and extensive physical investigations are greatly needed. G. Briegleb and W. Lauppe (*Zeit. physikal Ch.* (B), 1935, **23**, 154) show that as Raman spectra furnish an insight into the symmetry and binding state of molecules, a comparison of the spectra of a molecular compound with those of the components should give information about the changes in the symmetry and the binding state of the components caused by the molecular compound formation. Investigations carried out hitherto however show that no marked changes in the spectra are to be found when complexes are formed between like or unlike molecules solely on account of weak secondary valency forces. In the present paper a study of two definite molecular compounds HBr-ethyl ether, and $SnCl_4$-ethyl ether is reported. At room temperatures, a solution of HBr in ether gave the characteristic frequencies of ethyl bromide and thus showed that here the component molecules have actually reacted with each other. At $-40°$ however, a new spectrum different to that of the component molecules was obtained, corresponding to the existence of a definite inter-molecular compound. In the second case investigated, the frequencies of $SnCl_4$ were found to be considerably influenced possibly on account of a distortion caused by the neighbouring ether molecule. Further details and other studies are to be reported later.

M. A. G.

Radioactivity of Potassium and Rubidium.

THE emission of β-rays by Potassium and Rubidium has been known for some time, but the problem of deciding the exact nature of the disintegration process has been offering various theoretical and experimental difficulties. The long life period of Potassium and Rubidium and the high velocity of the β-rays emitted by them are not to be expected from theoretical considerations. Klemperer (*Proc. Roy. Soc.*, 1935, **148**, 638) has critically examined the different schemes suggested by Gamow for the disintegration process. (1) Simultaneous emission of 2 β-rays for each decaying atom. (2) An α-ray change followed by a fast β-ray change. (3) The Ca and Sr formed as a result of slow β-ray change from K and Rb respectively, may decay rapidly giving fast β-rays. Klemperer has finally arrived at the conclusion that the radio activity is not due to K_{39} and K_{41} but to K_{40}, and in the case of Rubidium to Rb_{85}. The process suggested is as follows :—

$$K^{40}_{19}\rightarrow\beta+Ca^{40}_{20}$$
$$Rb^{86}_{37}\rightarrow\beta+Sr^{86}_{38}$$

Of the two groups of β-rays emitted, one of them may be connected with γ-ray emission. It has been shown that K^{40}_{19} has a resultant nuclear spin of 4 or 5 while Ca^{40}_{20} has zero spin. Since according to the Fermi theory the life-time of a β emitting radio element depends upon the initial and final spin of the nucleus, the contradiction between half life period and β-ray activity of Potassium and Rubidium is cleared up.

M. P. V.

Distillation with Mercury Vapour.

DISTILLATION with steam is a well-known and important method used widely in the separation and purification of organic compounds. For substances of boiling point 400° or over, however, this method cannot be employed. H. Decker (*Ber.*, 1934, **67**, 1636) has now carried out some successful experiments using mercury in the place of steam. He finds that many high boiling compounds go over with mercury nearly

a hundred degrees below their boiling point, the volume of mercury coming over, in the cases investigated being but 1/10 of the distillate. The distillation can be carried out in a perfectly smooth manner. Indigo, chrysen and pyren are among those tried. It should be possible to distil out the high boiling compounds from such substances as resins and pitch, and the various other possibilities of this method have yet to be worked out.

M. A. G.

Action of Water on the Latent Photographic Image.

FORMATION of a flat image, if considerable time elapses between the exposure and development of photographic emulsion kept in a warm humid climate is a common experience. Howard James and co-workers (*J. Phys. Chem.*, 1934, **38**, 1211) have made systematic investigations on the rôle played by water in the above effect. If Azo emulsion is exposed to light so as to produce a considerable developable density, the latent image is either reduced or completely destroyed by the action of water vapour for several hours. Bromide emulsion requires longer treatment with water vapour. The dried emulsion gives a satisfactory print on second exposure. Formic acid, acetic acid vapours and liquid ethylene glycol are even more effective than water vapour. Ether, ethonol (absolute), carbon tetrachloride, carbon disulphide, benzene and nitro-benzene are however without any appreciable effect, in the vapour phase. The softening action common to the first group of substances on gelatin, probably facilitates the reversal of the exposed grain.

According to photographic theory, exposure of the emulsion to light results in the liberation of equivalent quantities of silver and halogen and the latter taken up by "the halogen acceptor". Gelatin in gelatin emulsion usually plays the rôle of the halogen acceptor. A more powerful halogen acceptor, like silver nitrate in the gelatin emulsion, will prevent the action of water vapour on the reversal. Complete destruction of the image is not possible unless the light exposure is small, and the amount of residual density increases with the period of exposure. On strong exposure some of the halogen is probably removed from the sphere of action and consequently the image cannot be completely destroyed. Water vapour has also sensitising action on the emulsion. The unexposed emulsion on treatment with water vapour and drying acquires increased sensitivity. Water vapour treatment over several days produces fog which resembles very closely that due to age (age mottle).

K. S. R.

The Cotton Wilt Disease in Bombay.

A full and connected account of the ten year research work on the Wilt Disease of Cotton carried out as one of the research schemes financed by the Indian Central Committee by Mr. G. S. Kulkarni and his assistants on the Dharwar Experiment Station appears in the *Indian Journal of Agricultural Science*, Vol. 4, Part VI. The studies have related to practically every relevant factor but from the point of view of controlling the disease they have yielded no useful results. In the last resort the breeding of resistant types appears to be the most promising line of work. Resistant types evolved by selection alone proved low yielders and therefore commercially of little value. The need for combining resistance with high yield by cross-breeding and also of a study of the different physiological strains of the fungus itself together with the reaction of the types of plants evolved to each of these strains is indicated. The observation that soil temperatures between 20° C. and 27° C. constitute the optimum for the development of the disease is made use of in a technique for testing types for wilt resistance rapidly. Provincial research to evolve types suited to the different important cotton tracts appears to be the only means of solving the difficulty.

The Farm Cart with Pneumatic Dunlop Tyres.

RESULTS of comparative tests regarding the performance of farm carts fitted with pneumatic tyres as against the ordinary steel tyred carts are summarised in the *Journal of Agriculture and Live-stock in India*, Vol. 5, Part I. The summary relates to trials conducted in Lyallpur in the Punjab and at the Agricultural College Farm, Poona. The draft with the rubber-tyred cart is greatly reduced, the reduction varying from 26 to 39 per cent. depending upon the load carried and the kind of road traversed. With a draft ranging between 200 lbs. and 250 lbs. the country cart pulls a load of one

ton while the rubber-tyred cart pulls about two tons. Tests relating to durability are still wanting and the relative costs for the new equipment over a reasonably long working period have still to be worked out.

Production of Canesugar in India in 1933-34.

THE SUGAR Technologist to the Government of India gives an account of the progress of sugar making in India during 1933–34 in the *Journal of Agriculture and Live-stock in India*, Vol. 5, Part I. The number of factories that worked during the year was 112 as against 57 during the previous year, a truly astonishing advance due certainly to the protection which the sugar industry now receives. About 15% of the factories worked between 150 and 174 days, 20% worked between 125 and 149 days, about 21% worked between 100 and 125 days and 25% worked between 75 and 100 days. Only one factory worked up to 200 days and one likewise over 200 days. The working season of the remainder was under 75 days. The maximum daily crushing for any factory was 1,604 tons of cane, while the lowest was only 15 tons. The outturn of sugar per cent. cane crushed taking all-India figures advanced only slightly over those of previous years, being only 8·80, which compared with the 11 to 12% outturns of Java should be deemed to be low. The damage due to frost, floods and insect pests, and the disastrous earthquake which occurred in Bihar, were responsible for the low outturn and the shortened crushing season of many factories. The Technologist strongly stresses the importance of well-qualified technical experts in the factories to ensure efficient working. The total production of sugar for the year was 453,965 tons as against 290,177 tons in 1932–33.

The Utilisation of Cane Molasses as Cattle Feed.

LABH SINGH records some further observations on these trials in the *Journal of Agriculture and Live-stock in India*, Vol. 5, Part I. These further trials disclose the rather important result that cattle fed on molasses in the summer months are injuriously affected. It is recommended that molasses feeding be confined to the winter months and up to a quantity of 2 lbs. per animal.

The Pollination of the Apple.

VERY interesting observations of much practical importance made as the result of a four years' study are recorded in *Bulletin* No. 162—New Series, of the Canadian Department of Agriculture. All varieties of apples produce better crops when cross-pollinated with another suitable variety with the exception of "Baldwin" which is self-fruitful. There is much difference in respect of the suitability of varieties as cross-pollinators, and a list of those suitable and unsuitable among the ordinary commercial varieties is given. Among the former are Alexander, Cox's orange, Jonathan, Rome Beauty, while among the latter figure Blenheim, Gravenstein and Ribston. A second point brought out is that insect pollinators are required by all varieties, wind pollination alone giving unsatisfactory results. The need for the provision of colonies of bees in apple orchards is emphasised.

Entamœba Kamala n. sp.

UNDER the title "Etiology of Enzootic Bovine Hæmaturia" Captain S. C. A. Datta, B.Sc., M.R.C.V.S., has contributed a very valuable article to the *Indian Journal of Veterinary Science and Animal Husbandry*, Volume IV, Part IV. Although Bovine Hæmaturia has been known to occur in countries as widely separated as Australia, Great Britain, and parts of Europe and America and India, yet very little is definitely known as to its nature and cause. In this article which is profusely illustrated with plates definite evidence has been furnished to prove that it is a parasitic disease due to a large protozoan organism which seems to belong to *Phylum Rhizopoda*. It is similar to but larger than *Entamœba histolytica* and affects bovines. The author proposes therefore the name *Entamœba Kamala* for this new species of parasite. As this knowledge is bound to be of great value in the control of the scourge, Captain Datta deserves the gratitude of the Veterinary Profession and the stock-owning public. His further notes on the subject will be keenly awaited.

S. D. A.

Effect of X-Rays on Chromosomes.

C. L. HUSKINS AND A. W. S. HUNTER (*P.R.S.* B, 1935, **117**, No. 802) have described a few examples of breaks and translocations of

either whole chromosomes or of their constituent chromatids caused by X-irradiation in the nuclei of the microspores of Trillium. Lateral translocations of fragments on to a broken chromatid were found with a high frequency in the first mitotic prophase after irradiation. The six anthers of a bud in this species are usually at the same stage of mitotic cycle and thus it was possible to determine with accuracy the exact stage of division at the time of irradiation, by immediately fixing one of the anthers. Apparent constrictions of chromosomes were found upon destaining to be merely chromatid breaks. Cases of *de novo* origin of trabents and an example of ring-formation have been recorded. The "delayed action" of X-rays, so commonly observed by several authors to become apparent first in the anaphase of the first division following irradiation, is explained on the basis that chromatid breaks will not be obvious before anaphases in chromosomes which are not stained to show the internal structure and that they may, owing to the surrounding matrix which holds them together, not be seen until the next division. The arguments of Darlington, and Mather and Stone on the time of chromosome splitting are critically analysed and the conclusion is reached that the somatic chromosomes of Trillium microsporocytes, including the "attachment constriction" are longitudinally double at all stages except just prior to anaphase separation when they are 4-partite.

Somatic Synapsis in *Chironomus*.

R. L. KING AND H. W. BEAMS have described (*Journal of Morphology*, 1934, **56**, 527) the somatic chromosomes of *Chironomus*. The diploid number is 8. In the spireme nuclei of Salivary glands they find four segments, each representing a pair of homologous chromosomes in intimate somatic synapsis. Each pair could be recognised by its characteristic distribution of chromatin discs. The somatic synapsis in *Chironomus* is not a simple approximation of homologous chromosomes, but can be compared to meiotic synapsis.

Development of *Cheyletus eruditus*.

OUR knowledge of the developmental history of Acarina is very meagre and the interesting article by H. A. Hafiz [*Proc. Roy. Soc. Lond.* (B), 803, 1935] is certainly welcome. Earlier investigators like Kramer, Claparéde, Michael, Neustead and Duval have restricted themselves to the description of a few stages. The cellular development in a parthenogenetic individual like Cheyletus clears some very abstruse points in the organogeny of the mites. He has studied from the blastoderm formation (which takes place from 1-4 hours) up to the final stage, *i.e.*, the emergence of the hexapod larva (92–96 hrs.). A single layer of blastodermal cells is formed; this differentiates itself into a median and two lateral plates. The ventral plate elaborates endoderm cells; the middle plate gives rise to mesoderm cells. Five pairs of thickenings form the larval appendages. The absence of anus is characteristic of not only the adult but also the embryonic stages. "Salivary gland" cells arise in association with the trachæ.

Diorite–Limestone Reaction, a Study in Contamination.

IN the current issue of the *Geological Magazine* (March 1935, No. 849) Miss Joplin of Cambridge has contributed a very instructive article on the reaction between diorite and limestone and consequent contamination. The area studied is situated in New Soutn Wales and is made up of shales, quartzites and limestones. The limestones have been invaded by a series of tongues of diorite, and these have been contaminated by the assimilation of lime and has given rise to definite and sharply marked off mineral assemblages. This reaction has produced well-marked zones which can be differentiated into diorite core, zone of turbid felspar, clinozoisite zone and garnet zone. By a detailed study of the chemical analyses of these different rocks, she has been able to deduce certain physical conditions controlling contamination. By comparing these deductions with the well-known works of Eskola, Read and Tilley she concludes that the degree of concentration of the foreign material is the most important factor in contamination and that assimilation takes place at a low temperature in the presence of abundant volatiles of which water is the most important.

The National Institute of Sciences of India.

By L. L. Fermor, O.B.E., D.Sc., F.G.S., F.R.S.

THE extent to which modern civilised man has become dependent in all directions for his welfare and happiness upon the results of scientific researches and their applications has for some decades caused all civilised countries to make provision for such research. This research is financed by one or more of four agents, namely, (1) the State, (2) educational organisations and institutions, (3) commercial and industrial concerns, and (4) private benefactors; and the total amount of such provision and the proportion of its derivation from these four sources depend partly upon the general wealth of a country, partly upon the extent and variety of its natural resources, and partly upon the general degree of education and enlightenment of its inhabitants, the last factor being usually the most important.

In India, although the larger proportion of the population has been illiterate through the ages, there has always been a nucleus of men of learning, and in very early days some attention appears to have been given to scientific studies, particularly mathematical and astronomical and also in natural history. The full extent and value of the knowledge so acquired is not yet known, and probably never will be known, as its discovery depends upon the interpretation and elucidation of ancient manuscripts, many of which are either lost or very fragmentary.

The course of the study of modern science in India has been discussed briefly in two recent addresses. In my Presidential Address to the Asiatic Society of Bengal in February I have given a sketch of the development of scientific research in India to the end of the 19th century, whilst in my Inaugural Address to the National Institute of Sciences of India in January, I gave an account of the development of scientific research in India in the 20th century. The two addresses, although to some extent overlapping, really form a continuous story, and the reader may be referred to them in their respective publications.*

Your Editor has asked me to write an article on the National Institute of Sciences of India. In accepting this invitation it has seemed to me that it would be useful if I showed the position of this organisation with reference to other scientific organisations in India, as it is only in this way that one can see clearly what place the National Institute should occupy in the edifice of Science in India, and, therefore, what its functions should be.

Briefly, the position is that provision for modern scientific work in India commences in the days of the East India Company with the recruitment of Medical Officers and Mint Assayers, who, towards the end of the 18th century, with interested civil and military officers, began in their spare time the first modern scientific investigations. At this time the general need for an organised association for the encouragement of the study of all branches of learning became felt, and on the 15th of January 1784, at a meeting presided over by Sir William Jones, the Asiatick Society was founded, later to be termed the Asiatic Society of Bengal. The objects of this Society were both scientific and literary, and in the comprehensive words of Sir William Jones as paraphrased "The bounds of its investigations will be the geographical limits of Asia, and within these limits its enquiries will be extended to whatever is performed by man or produced by nature".

The first organised provision for scientific research in India was, therefore, actually non-official; but in 1788, the Royal Botanic Gardens, Sibpur, were founded; and in 1800 the first of the scientific services, namely the Trigonometrical Survey of the Peninsula, later to become the Great Trigonometrical Survey and now merged in the Survey of India, was established by the East India Company with Colonel Lambton as the first geodesist. The Geological Survey of India was founded in 1851, and in 1866 the first Museum Act was passed and the Indian Museum was established, the zoological, geological and archæological collections of the Asiatic Society being transferred thereto; and with the foundation of this Museum we have the first direct official provision for zoology. Provision for meteorology in the form of various observatories existed in various parts of India from the end of the 18th century and in the early 19th century, and in 1875 the Government of India appointed a Meteorological Reporter for the

* *Journal and Proceedings of the Asiatic Society of Bengal* and the *Proceedings of the National Institute of Sciences* respectively.

whole of India, and the present Meteorological Department was founded.

The 19th century was thus a period during which the various scientific services financed by the Central Government were founded. All these services eventually inaugurated their own publications, but throughout this period the Asiatic Society of Bengal was the place where men of all branches of knowledge met and discussed their problems, and the publications of this Society contain not only literary communications but also many papers of importance to Science. During the 19th century, branches of the Royal Asiatic Society of Great Britain and Ireland were established in Bombay and Madras, and that very successful Society, the Bombay Natural History Society, was also founded. There were also other less important societies, often evanescent; but on the whole it was a century characterised by the existence of scientific services and of one academy serving the whole of India, namely the Asiatic Society of Bengal. None of the specialist scientific societies had been founded, and the major portion of the researches that were not published in departmental publications found their way to the Asiatic Society of Bengal.

With the 20th century we have opened another volume in the scientific life of India, and the first third of the century has been characterised by the formation of a large number of specialist societies and research institutes. Amongst the societies mention may be made of the Mining and Geological Institute of India (1906), the Indian Mathematical Society (1907), the Institution of Engineers, India (1921), the Indian Botanical Society (1921), the Indian Chemical Society (1924), the Institution of Chemists, India (1927), the Society of Biological Chemists (1931), and finally of the Indian Physical Society, the Indian Society of Soil Science and the Indian Physiological Society, all founded last year.

Amongst the research institutes supported from central revenues one may mention the Imperial Institute of Veterinary Research now at Muktesar but originally founded at Poona under another name (1890); the Imperial Agricultural Research Institute, Pusa (1903); the Central Research Institute, Kasauli (1906); the Imperial Forest Research Institute, Dehra Dun (1906); and the All-India Institute of Public Health and Hygiene, Calcutta (1934). As examples of research institutions administered provincially mention may be made of the School of Tropical Medicine, Calcutta, and the Haffkine Institute, Bombay. And as a fine example of another type of research institute, namely one supported mainly by private bequests supplemented by Government grants, we have the Indian Institute of Science, Bangalore (1911).

All these societies and institutes, except the Indian Institute of Science, must be regarded as specialised organisations.

But starting in 1857, with the foundation of the Universities of Bombay, Calcutta, and Madras, there has been formed a series of university educational institutions with chairs and laboratories for various science subjects, playing an important part in the provision of facilities for scientific research. The scientific societies all maintain their own publications, but happily the tendency is for our University friends to offer the results of their researches to existing scientific societies rather than for Universities to start their own journals and so increase the multitude of publications.

The tendency of the 20th century in India has been, therefore, towards intense specialisation in science with resultant segregation of scientists into specialised bodies. Fortunately, however, this tendency was recognised quite early in the century and the Indian Science Congress was founded (1914) deliberately to lead men of all branches of science back to a common meeting ground. This body, however, meets but once a year and does not, therefore, provide for the periodic meetings of men of all sciences throughout the year.

As already explained the Asiatic Society of Bengal provided such a forum throughout the 19th century. This was during the period when by far the larger part of the scientific research done in India was based on Calcutta or found its way there due to the presence of the Central Government. But there are now numerous other research centres in India and consequently, as India is a large country equivalent in size to the continent of Europe without Russia, it follows in practice that men of all centres of research cannot make personal use of the Asiatic Society of Bengal, which, though an All-India Society and, in fact, if one attends to its original objectives an All-Asia Society, can, for geographical reasons, in many respects serve practically only a limited portion of India.

It was this practical difficulty that really led to the foundation of the United

Provinces Academy of Sciences in 1930, and later to a demand for an Indian Academy of Sciences, the later demand overlooking the fact (1) that in the Asiatic Society of Bengal there was already—though not under that name—an Indian Academy of Sciences and Letters theoretically available to represent and cater for the whole of India, and (2) that in practice no one society of Academy rank could cater effectually for the whole of India.

The disagreement amongst scientists in India during 1934 over this Academy problem, though it arose otherwise, was fundamentally due to these facts; and in the end practical recognition has been given to the fact that scientists in India need for their continuous service at least three Academies of Science, and as a result we now have the three Academies located respectively in Calcutta (Asiatic Society of Bengal), Allahabad (United Provinces Academy of Sciences), and Bangalore (Indian Academy of Sciences).

As I have pointed out in the Addresses referred to above, Academies must really be regarded as philosophers' gardens, where men of various branches of knowledge can walk and talk, compare their views, and discuss their problems; and it is in providing a place where men of various branches of knowledge can meet and talk that Academies are to be distinguished sharply from specialist societies.

Whilst it has become clear that no one Academy can serve the practical needs (apart from those served through the post) of the whole of India, it is also clear that we require a co-ordinating body to facilitate co-operation in the first instance between the various Academies, but ultimately between all scientific organisations and scientists, and it is this underlying need that has really led ultimately to the formation of the National Institute of Sciences of India.

It is unnecessary to explain at length the objects of this Institute. It is sufficient to reproduce Rule 2 of the Provisional Rules of the National Institute:—

OBJECTS.

2. The objects of the National Institute of Sciences of India are:—

(*a*) The promotion of natural knowledge in India including its practical application to problems of national welfare.

(*b*) To effect co-ordination between scientific academies, societies, institutions and Government scientific departments and services.

(*c*) To act as a body of scientists of eminence for the promotion and safeguarding of the interests of scientists in India; and to represent internationally the scientific work of India.

(*d*) To act through properly constituted National Committees in which other learned academies and societies will be associated, as the National Research Council of India, for undertaking such scientific work of national and international importance as the Council may be called upon to perform by the public and by Government.

(*e*) To publish such proceedings, journals, memoirs and transactions and other publications as may be found desirable.

(*f*) To promote and maintain a liaison between Sciences and Letters.

(*g*) To secure and manage funds and endowments for the promotion of Science.

(*h*) To do and perform all other acts, matters and things that may assist in, conduce to, or be necessary for the fulfilment of the above-mentioned aims and objects of the Institute.

It seems unnecessary to discuss in detail the various objects of the Institute, as each of them speaks for itself. But from the statement it will be seen that the main objects of the National Institute are related to the co-ordination and organisation of science in India, and this is the reason why the Institute has a limited Fellowship composed of Fellows belonging to all branches of science.

In the first year or two of its life the Institute will naturally proceed cautiously, but gradually, as opportunity occurs and funds permit, scientists in India must expect the National Institute to take up all the objects enumerated above, and as this is done we shall call upon the Academies and the specialist societies for their co-operation.

Although this is not the main object yet it is inevitable that when the Fellows meet they should take the opportunity to bring researches of general interest before the whole body of Fellows, and to this extent the National Institute must serve as a forum where important discoveries are announced and discussed.

In Rule 2 (*e*) reference is made to possible publications of the National Institute. The publication of *Transactions* and *Proceedings* has been commenced, but the most important publications are expected to be an annual review of science and a publication containing collected summaries of papers read before Academies and scientific societies in India.

As is now known to all scientists in India, the foundation of this National Institute represents an act of co-operation between the senior scientists of all parts of India. The Council has been chosen so as to give a

wide geographical distribution of Members of Council, including provision for an additional Vice-President and an additional Member of Council representing each of the three existing Academies and the Indian Science Congress, and all these bodies have shown their co-operative spirit by duly appointing their representatives to the Council. The Fellowship of the Institute includes representatives of all sciences; of the scientific services, of the universities, of the research institutions, and of scientists employed by commercial and industrial organisations; and the National Institute represents the co-operative effort of men of all races, religions and branches of science in India. It is hoped that the country will be proud of this comprehensive organisation and that all scientists will regard it as an honour to be elected a Fellow thereof.

There is an urgent need in India for co-operation between men of different communities, and I take this opportunity to express the hope that we shall succeed in providing in this National Institute a bond between scientists throughout India and an organisation that will act by its existence and its success as an example and an encouragement to men of other walks of life, by showing what is possible in the way of co-operation between men of diverse and yet ultimately similar interests.

Science Notes.

X-Ray and Photographic Reversal.—Messrs. K. Prosad and B. N. Ghosh, Science College, Patna, write under date 23rd February 1935, "When materials are exposed to a beam of X-ray for the purpose of obtaining their diffraction halos, it is a familiar fact that the impression of the direct beam on a photographic plate on development, comes out sometimes dark and sometimes white. This phenomenon does not appear to have attracted sufficient attention, much less investigated in any detail.

While engaged in confirming with the help of X-rays, the results of structural analysis of some solids as obtained by the method of Latent Splitting (*Nature*, 1931, **127**, 90; *Bulletin, P. S. C. Phil. Soc.*, 1933, No. 3; 1934, No. 4; 1935, No. 5), the attention of one of us was drawn to the apparently irregular manner in which the central spot on the negative came out dark or white depending on the length of exposure. The appearance of the impressions suggested that the phenomena might be due to photographic reversals by X-rays. To test this suggestion, a systematic investigation has been undertaken using a Hadding tube. Exposures on Golden Iso Zenith plates of speed 1100, with 10 milliamperes fixed discharge at 50 KV, using a copper anticathode, have been given for times varying from 1 sec. to 5 hrs. The result has been a series of negatives of a highly interesting character in which opacity and transparency alternate with each other varying in intensity with time.

The first reversal, that is, transparency superposed on the opacity of the image appears for about 10 mts. exposure. The transparency then gradually increases until an exposure of about 2 hrs. is reached when an opacity is again superposed on the former transparency. This second opacity increases upto an exposure of about 3 hrs. At this point a second transparency sets in which slightly increases upto an exposure of about 3½ hrs. A third opacity then starts which increases upto an exposure of nearly 4¼ hrs. A third transparency is then again noticeable superposed on the last opacity and increases in magnitude upto an exposure of about 4¾ hrs. At this point a fourth opacity sets in which goes on increasing upto the maximum time of exposure of 5 hrs. given in these experiments. The differences between successive maxima of opacity and transparency gradually diminish and will probably disappear with still longer times of exposure.

Although the phenomena of one or two photographic reversals (R. W. Wood, *Phil. Mag.*, 1903, **6**, 577), with stimuli of different kinds used in certain order or those due to overexposure using ordinary light are well known, it is however not certain that several reversals with one kind of stimulus, specially with the X-rays, have been previously obtained. A very interesting account of the existing knowledge on the subject is given in Chapter XV of Allen's book on Photo-Electricity. Fuller details of the work will appear elsewhere."

* * *

Fossil Wood from the Bababudan Hills, Mysore.—Charles S. Pichamuthu writes that while examining the iron ore deposits of the Bababudan Hills during the Dasara vacation in the year 1932, the writer came upon a specimen of fossil wood near Kemmangundi. It was found near the 6th furlong of the 27th mile on the Chikmagalur to Lingadhalli road. The road here has been cut along the sides of the hill, and it was from this cutting that the specimen was obtained. The hill, which is 4,500 feet above sea level, is composed of red earth containing lumps of iron ore.

The woody material has been completely converted into hematite. As the fossil was of a rather friable nature, it was with great difficulty that it could be sliced. The specimens and sections were kindly examined by Professor John Walton, Professor of Botany in the University of Glasgow. He was of opinion that it was fossil wood, but considering the imperfect preservation of the structures, he did not like to say more than that it was of gymnospermous character. Recently, specimens were sent to Dr. Sahni who agreed with Professor Walton's identification.

The iron ores (as opposed to the banded ferruginous quartzites) of the Bababudans, have been, in part, segregated by the action of water through the ages. Some of the ores have

undoubtedly accumulated in standing bodies of water, solutions having leached the iron from the ferruginous quartzites. This specimen of wood must have been washed into one of these sedimentation areas and had its woody material replaced by oxide of iron.

It may be mentioned that there are, at present, no gymnosperms on these hill ranges.

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The Porphyry Dykes of Mysore—A Study in Contamination.—B. N. Raghunatha Rao, writes that in describing the "Closepet Granites" of Mysore the Officers of the Mysore Geological Department have frequently noticed cases of local contamination of the acid magma by basic material. A very good example of such a contamination on a wider scale is afforded by the porphyry dykes of Mysore (Mandya and Seringapatam Taluks), which I have been recently studying. These dyke rocks appear to have consolidated from a highly contaminated magma due to the relatively more acid residual phases of the "Closepet Granite" magma having more or less assimilated portions of the basic country rocks such as the hornblende schists, chlorite schists and the pyroxene granulites—thus giving rise to the dykes of a monzonitic character. Among the chief evidences in support of such a view may be mentioned :—(1) the constant presence of basic xenoliths in these dyke rocks, in all stages of assimilation and recrystallisation, (2) the abundant development of sphene, apatite and magnetite in the proximity of these basic xenoliths, (3) the frequent occurrence of minerals such as melanite and spinel, and (4) the heterogeneity in the general character of the dykes occurring in a group—as for instance near Bethalli and Arakere.

Further work is in progress and a fuller paper dealing with the subject will be published elsewhere.

* * *

The Blue Colour of the Sky.—Dr. M. Zakiuddin writes: "In a previous communication (*Current Science*, 1934, **3**, 83) I have mentioned about the interesting manuscript of Al-kandi dealing with the blue colour of the sky, a copy of which is preserved at Oxford (No. 877, *Katalog der Bodleiana von J. Uri.*, Bd. 1) and a copy of which has been recently discovered by H. Ritter (*Archiv. Orientalni Prage*, pp. 363-372, 1932). The manuscript has been also edited at Aligarh after a careful comparison as it has been found that the copy preserved at Oxford is full of mistakes.

It is interesting to note that Prof. E. Wiedemann (*Arbeiten ans den Gebieten der Physik, Mathematik, Chemie - Julius Elster und Hans Geitel*, pp. 118-126, 1915, called "Anschaungen von Muslimischen Gelehrten uber die blaue Farbes des Himmels"), of Edlangen has translated the Oxford copy. Wiedemann, however, mentions a very interesting manuscript dealing with the problem of the blue colour of the sky by the Egyptian jurist Qarafi (Eder—*Jahrbuch der Photographie and Reproduktintechnik*, 1913 and 1915).

Schihâb al Din Ahmed Ibu Idrio al Qarafie lived in Cairo and has written a book on 50 different problems of optics. He died about 1283-84. Of all these problems, the problems No. 33, 34, 35 deal with the cause of the blue colour of the sky (*loc. cit.*).

Later on Wiedemann mentions of another manuscript of Qazwini (*vgl. Z. B.*, Qazwini Bd. 1, Text S. 170 von Ethe 347) that also deals with the same problem.

* * *

The Association of Special Libraries and Information Bureau (ASLIB) is to hold its twelfth annual conference at St. John's College, Cambridge, during the week-end beginning Friday, September 20. Particulars may be obtained from the Secretary of the Association, 16 Russell Square, London, W. C. 1. Sir Richard Gregory has agreed to accept re-nomination as president of the Association for 1935-36.—(*Nature*, March 1935.)

* * *

Seasonal Progress of Height Growth in Trees.—By H G. Champion. (*Forest Bulletin*, No. 88, Silvicultural Series, 1934. Government of India Publication.)

"Data for the seasonal progress of height growth collected between 1922 and 1933 on 15 common Indian trees are examined and average curves derived. The marked variation in the increment curves in successive years is discussed in relation to the curves for temperature, rainfall and soil moisture, close agreements being few. The specific increment curves are classified into three types: (i) simple curve with single maximum (*Adina* and *Tectona*), (ii) curve relatively simple but with secondary maxima (*Terminalia*), (iii) curve complex with two or more primary maxima (*Shorea*, *Pinus* and *Eugenia*)."

* * *

The Distribution of Temperature in the Upper Levels of a Depression Originating in the Bay of Bengal during the Indian South-West Monsoon. By N. K. Sur (Indian Meteorological Department, *Scientific Notes*, Vol. VI, No. 62).

"During the period of activity of the south-west monsoon some depressions originate in the Bay of Bengal preceded by a well-marked fall of pressure in Burma. These generally move in a north-westerly direction through the central parts of India and reach the neighbourhood of Rajputana. Sounding balloon ascents at Agra, when one such depression was passing through Rajputana, show that the upper levels of air in its outer regions were characterised by temperature lower than the normal values for the corresponding heights in the monsoon season. The level of tropopause above the depression was also found to be lowered."

* * *

Goat Breeding Scheme for South India.—The Imperial Council of Agricultural Research, New Delhi, at their meeting on February 28, 1935, sanctioned a ten-year scheme for Goat breeding under the auspices and direction of the Arcot Mission Agricultural Institute, Katpadi. The anticipated and sanctioned expenditure is Rs. 84,172 including Rs. 5,480 as non-recurring and Rs. 78,692 as recurring expenditures.

OBJECTS OF THE EXPERIMENT.

The Madras Presidency is reported to have eleven million goats of a non-descript variety. Among them exist great differences as to colour, size, milking capacity and other characteristics associated with a definite breed. The purpose of this research project is to make a concentrated attempt to select certain types and strains and with a definite ideal in mind work toward the consolidation of desirable characteristics into a definite breed indigenous to South India. The

plan is to have 200 females in the milking herd of which half the number will be used to breed South Indian varieties pure; one-fourth blood from the Jumna-Pari from North India will be used and Surti blood from Western India on the remaining fourth. Comparative figures will be kept of such factors as milk production, hardiness, prolificacy, milking longevity, intervals between kiddings, suitability of various feeds and fodders and observations of diseases and their treatment.

Propaganda work will also be carried on educating the public especially the poorer village classes who cannot afford the risk of maintaining the better grade of cattle, in the advantages of the "Poor man's cow" especially for milk production to improve the rather poorly balanced villagers' diet. Animals from these improved varieties will be put at stud in the district to improve the local goats.

EXPENDITURES.

The Imperial Council has agreed to make the following sums available for the experiment :—

	Rs.
1. Purchase of stock, office and dairy equipment	5,480
2. Staff—Assistant, writer, maistry and coolies	26,928
3. Feeding expenses for the goat herd ..	45,564
4. Recurring, office, dairy and sundry expenses	6,200
TOTAL EXPENDITURE ..	84,172

The American Arcot Mission agree to give the services of Mr. J. J. De Valois, the Principal of the Agricultural Institute, to supervise the work as well as to provide the necessary buildings of a very simple but suitable nature for the project.

The scheme was drawn up with the co-operation of the Madras Agricultural Department officers who were interested in the work the Mission was doing with goats on a very small scale. The Director of Agriculture, Madras, was largely responsible for securing the final approval of the Imperial Council authorities.

* * *

We have great pleasure in congratulating Dr. T. Vijayaraghavan, (at present) Reader in Mathematics in the Dacca University, on his election as Visiting Lecturer for 1936 by the American Mathematical Society. He is the first Oriental Scholar to receive the distinction, which is conferred on very able non-American mathematicians achieved hitherto only by a few European workers of the front rank. Vijayaraghavan's ability was first noticed during his undergraduate years by Prof. K. Ananda Rao of the Presidency College, Madras; his original papers were forwarded to Prof. G. H. Hardy in England who unhesitatingly placed him second, even at that early age to the late S. Ramanujam. He was awarded a special scholarship of over a thousand pounds by the Madras University for research in England under the guidance of Prof. Hardy, then at Oxford. He published three papers on Tauberian Theorems which have become an integral part of the standard literature on the subject. These and some other minor papers won for him the Doctorate Degree.

Subsequently he published his paper dealing with the famous Borel conjecture in the *Comptes rendus* of the Paris Academy in 1932.

Émile Borel, one of the outstanding mathematicians, made a highly plausible conjecture in 1899 on the orders of infinity of solutions of differential equations. It was immediately accepted by all, including Hardy, as true; but years passed by without a single proof in spite of all the efforts of the best mathematicians all over the world. The problem came to be ranked as one of great difficulty, being slightly less than those of the Riemann hypothesis, Fermat's last theorem and Goldbach's theorem. As such it was suggested by Hardy to the mathematical workers in his seminar lectures. After six years of quiet work, Vijayaraghavan proved Borel's conjecture as also that of others to be wrong, the conjecture, natural as it appears, being actually false! The little note referred to above ranks as one of the greatest achievements of recent mathematical thought, not only by its conclusions but in the elegance of method, finish of technique and incisive of analysis.

We wish all success to a scholar who is still young. We have no doubt that he will bear with honour a large share of the burden left upon mathematicians in India by the premature death of Ramanujam.

* * *

The Institute of Chemistry of Great Britain and Ireland (Indian Section).—The Annual General Meeting of the Indian Section of the Institute of Chemistry of Great Britain and Ireland was held at the University, Calcutta, on January 5th, 1935, Dr. H. B. Dunnicliff, D.Sc., F.I.C., in the Chair.

The Report and financial statement presented by the Honorary Secretary was read and approved.

The following members were elected to the Committee for the year 1935.—

Mr. G. C. Mitter, M.Sc., A.I.C., Bombay; Dr. R. H. Peacock, D.Sc., F.I.C., Burma; Dr. E. Spenser, D.Sc., F.I.C., Bengal; Dr. B. B. Dey, D.Sc., F.I.C., Madras; Dr. J. N. Ray, D.Sc., F.I.C., Punjab; Dr. S. Krishna, D.Sc., F.I.C., United Provinces; Mr. G. W. Douglas, B.Sc., A.I.C., Honorary General Secretary.

A number of matters relating to the proposed Sectional Rules and to the formation of subsections in India were discussed, the meeting terminating with a vote of thanks to the Chairman and Honorary Secretary.

* * *

International Society of Leather Trades Chemists (Indian Section).—The Annual Meeting of the Indian Section of the International Society of Leather Trades Chemists was held at the Bengal Tanning Institute, Calcutta, on January 6th, 1935, with Mr. B. M. Das, President, in the Chair. The Annual Report of the Honorary Secretary was read and approved. A number of matters relating to the Sections activities were discussed and the hope expressed that all those who were interested in the Tanning Industry in India would avail themselves of the facilities provided by the Society. The following are the Committee for 1935.—

President.—Mr. B. M. Das, M.A., M.Sc.; *Committee.*—Messrs. B. B. Dhavle, M.A., A.I.C.; N. N. Dutt; R. F. Roll; C. O. Tattersall, B.Sc., A.I.C.; G. W. Douglas, B.Sc., A.I.C. (*Honorary Secretary*).

The meeting terminated with a vote of thanks to the Chairman and Honorary Secretary.

On the conclusion of the meeting the members present were shown over the Bengal Tanning Institute by the Superintendent, Mr. B. M. Das.

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Association of Economic Biologists, Coimbatore.—At a meeting of the Association of Economic Biologists, Coimbatore, held on the 7th March 1935, Dr. F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S., Director, Imperial Institute of Agricultural Research, Pusa, delivered an able address on "Chance and Error". On the 22nd March 1935, Dr. P. J. Gregory, M.A., Ph.D., F.R.M.S., F.L.S., delivered an illuminating lecture illustrated with lantern slides, on "the chromosome structure".

* * *

New Fellows of the Royal Society of Edinburgh.—According to an announcement in *Nature*, Dr. B. N. Desai, Assistant Meteorologist, Government of India, Dr. B. Narayanaswamy, Lecturer in Physiology, University of Patna and Mr. C. S. Pitchamuthu, Assistant Professor of Geology, University of Mysore, have been elected ordinary Fellows of the Royal Society of Edinburgh at a meeting held on 4th March 1935.

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We understand that Col. C. A. Gill, K.H.S., I.M.S., Inspector-General of Civil Hospitals, Burma, and late Director of Public Health, Punjab, has been appointed to undertake an investigation into the Malaria Epidemic in Ceylon.

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Dr. Ernest Muir, of the School of Tropical Medicine, Calcutta, will soon be leaving India after 29 years of work connected with leprosy relief and kala-azar, to become Medical Secretary of the British Leprosy Relief Association.

Dr. Muir first came to India in 1906 as a medical missionary to the U.F.C. Church Mission at Kalna, where he worked for 14 years. During the later part of his stay at Kalna he became greatly interested in the subject of Leprosy. He was responsible for starting the Leprosy Research Department at the Calcutta School of Tropical Medicine, in November 1920. Three fundamental problems in which he was interested in connection with Leprosy are (1) culturing of the organism responsible for leprosy on artificial media, (2) finding a suitable experimental animal susceptible to infection, and (3) the improvement in the treatment of leprosy, the present method being tedious and requiring prolonged treatment, Dr. Muir worked on these problems for 15 years, as a result of which India is now covered with a net-work of leprosy clinics. A heap of publications stand to his credit and in association with Dr. Napier he published a handbook on Kala-azar and with Sir Leonard Rogers a handbook on Leprosy.

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According to a note appearing in *Chemical Age* the Government of India reports that two separate agreements have been negotiated with Imperial Chemical Industries, Ltd., in connection with the Company's proposal to erect an alkali factory. One with the Punjab Government dealt with the supply of limestone, and the other with the Government of India referred to the supplies of waste salt, brine and other products in the Khewra salt mines. The agreement with the Government of India provided for a five-year option to the company to take up a fifty-year concession for the exclusive right to obtain the salty material in question, for use in a factory, subject to the safeguarding interests of the Government of India and of those concerns already established and which were engaged in the production of refined table salt. (*Chemical Age*, 1935, **32**, 230.)

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The Chemical Engineering Congress of the World Power Conference will be held under the auspices of the International Executive Council from June 23-27, 1936, at the Central Hall, Westminster, London. Information regarding the Conference can be obtained from the Congress Office, 56, Victoria Street, London, S.W.1.

* * *

Report of the Third Imperial Mycological Conference.—The Imperial Mycological Conference, held once in five years, affords an excellent opportunity for discussing Plant Pathological problems in the British Empire. The third conference was held in London during September 1934, and was attended by Plant Pathologists designated from all over the Empire. India was represented by Dr. W. McRae and Dr. Chaudhuri. It is interesting to note that representatives of firms, manufacturing fungicides also attended the conference.

After the opening address by Sir Charles Howell-Thomas, K.C.B., K.C.M.G., Dr. E. J. Butler, C.M.G., C.I.E., F.R.S., the Director, reviewed the work of the Institute. He gave staggering figures of annual crop losses due to fungal diseases in Great Britain, the Irish Free State, Australia, Holland and Switzerland. Cereal losses alone were estimated at £100 millions annually. He deplored the apathy of Government towards organising this branch of Agricultural Science and emphasised the need of co-operation between the Plant Pathologist and the Plant Breeder. It is interesting to learn that scale insects in the Seychelles, were effectively controlled by fungal cultures, obtained from Mysore, of *Cephalosporium lecanii*, which parasitises green bug on coffee.

The discussion on administrative measures (including Legislation) against plant diseases resulted in the adoption of a resolution recommending a uniform health certificate throughout the Empire. The possibility of introduction of plant diseases by air transport was also discussed, and it was recommended that there should be a general prohibition of transport by air of living plants. Methods of standardization of insecticides and fungicides were discussed, with the representatives of manufacturing firms.

The report of the discussion on virus diseases of plants and Foot rot of cereals contains valuable facts. The need for simplification of control measures suited to the small cultivator was emphasised, and formed the subject-matter for discussion. The important subject of breeding and selection for immunity against plant diseases was also discussed, and papers were read on various tropical diseases. The delegates visited the Imperial Mycological Institute, and the East Malling Research Station.

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Report of the Veterinary Director-General for the year ending March 31st, 1933 (George Hilton, V.S.H., A.R.C.V.S.), Department of Agriculture, Canada.—One of the most important activities of the Department was the prevention of importation of Epizootics especially, Foot and Mouth disease from Europe and the United States. Progressive measures for the control of Bovine

Tuberculosis have been adopted with the co-operation of the live-stock owners and public health bodies, with very satisfactory results. Attempts to similarly deal with bovine contagious abortion also which is gaining in prevalence are started. A Virus disease of foxes kept in captivity was studied which evidently resembles the distemper of dogs. A similar disease in sledge-dogs was investigated with the help of the Royal Canadian mounted police. Researches into Bovine Hæmaturia and Equine infectious anæmia (Swamp Fever) are undertaken besides other diseases.

At the Imperial Economic Conference, agreement was reached on several points, chief among which are reduction of the quarantine period for animals imported into Canada and curtailment of restrictions on Canadian cattle exported to Great Britain.

The most important feature of the report is, the splendidly organised campaign for the eradication of Bovine Tuberculosis. The measures adopted include, Single Herd policies, Accredited Herd plan, Supervised Herd plan and restricted area system. In some cities and towns the municipal tuberculosis order is in force under which dairy cattle are tested free with tuberculin and compensation is paid for reactors which are slaughtered. During the year, 79,805 tests were made and 987 reactors were slaughtered and compensated for under this order.—S. D. A.

* * *

Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the Year ending 31st March, 1934.—This report like its predecessors makes interesting and instructive reading. Details of the Establishment, Estate, Biological Products, Technical instruction, Publications by the staff and the financial position are furnished.

The following are some of the important findings in the Research Department :—

RINDERPEST :—Further tests with Goat Virus as an immunising agent against Rinderpest were conducted with encouraging results. This method of inoculation has been tried on a much larger scale in the provinces and the results are so satisfactory—mortality being negligible—that further extension of the work is predicted.

ANTHRAX :—Vaccination with formalinised tissues from animals dead of Anthrax were found safe for administration but the immunity conferred was not satisfactory.

BLACK QUARTER :—Finding immunity by muscle and culture filtrates not very effective, formalinised whole culture vaccines were prepared and used for the first time this year with very satisfactory results.

CONGENITAL AMAUROSIS :—Evidence has been produced to show that the blindness in calves often results from a deficiency of minerals or vitamins.

EPHEMERAL FEVER :—A case of this disease has been studied and it has been found possible to transmit it to healthy animals by inoculating the blood taken at the height of fever although animals in close contact would not contract it. As this disease seems to be of common occurrence in other parts of India, a more exhaustive study of it is imperative.—S. D. A.

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From a report appearing in *Statesman* of the 5th April, it is understood that the Royal Institution has decided to establish a Professorship of Astronomy and that Sir James Jeans has been nominated as the first holder of the Chair.

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The Health Commissioner of the League of Nations has arranged for a second course of instruction in Malariology which will commence at the King Edward VII College of Medicine at Singapore on the 29th April 1935. The theoretical and laboratory studies will continue until 2nd June after which the candidates will proceed in groups either to Malaya, Java or French Indo-China for a further period of practical field work extending over three weeks. Facilities will be provided for experienced Malariologists to pursue individual research during the period of the course and at other times by arrangement with the King Edward VII College of Medicine.

The object of the course is to complete the training of medical practitioners who are engaged or intend to be engaged in the work of malaria control in their own countries.

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International Committee of Annual Tables of Constants—$A.^{T}C.$—We are informed through the courtesy of the General Secretary of this important organisation, M. Ch. Marie, 9, rue de Bagneux, Paris (VI), that the Academy of Sciences of U.S.S.R. has signed an agreement with the Committee of $A.^{T}C.$

This agreement guarantees for the coming five years an important contribution to the International Fund of the publication of $A.^{T}C.$ In exchange the U.S.S.R. Academy of Sciences is to receive a certain number of volumes edited by the Committee of the $A.^{T}C.$ These volumes are going to be distributed among the Universities and Scientific Institutions of the Soviet Union.

Similar agreements have been already signed with the French Government, the Helvetic Government and the Polish Academy of Sciences.

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Hilger Catalogue F.—Spectroscopic and Other Accessories (54 pages, $9\frac{1}{4} \times 7$ ins.; with index; issued gratis). Adam Hilger Ltd., 98, Kings Road, Camden Road, London, N.W. 1.—Adam Hilger Ltd. issue a series of eleven principal catalogues of which the present Catalogue F. is a member. It deals with the wide range of accessories and minor apparatus that can be supplied for spectroscopic and other purposes. Some idea of the variety of these can be judged from the fact that in its 54 pages the following are listed among a large number of other items :—

Condensing lens and mounts, mirrors, absorption tubes and cells, various types of spectroscopic slits and eyepieces, levelling tables, vacuum pumps, discharge tubes, sodium and cadmium lamps, arc and spark stands, AC—DC rectifier, pure and rare metals, Judd Lewis comparator, thermopiles, photo-electric cells, photographic materials, and publications.

On page 40 a description is given of a new type of galvanometer relay which is capable of increasing the sensitivity of galvanometer systems several hundred times.

A comprehensive index is included. Prices are printed in a separate price sheet, a copy of which accompanies every catalogue.

The same firm are also issuing free of charge, a convenient stiff card folder in which their catalogues may be kept ready for reference on the bookshelf.

From an *Associated Press* message, we learn that the Tibetan Government has consented to a British Expedition to Mount Everest during 1935-36. Mr. Hugh Ruttledge has accepted the invitation extended by the Mount Everest Committee to lead the expedition.

The Government of India have sanctioned 3 Himalayan Expeditions (1) Dr. Schiebe will lead a party of German Botanists, who intend exploring the botanical potentialities of Chitral, (2) Dr. Ph. C. Visser, the Netherlands Consul-General in India and Ceylon will lead another Expedition this summer to the Shaksgam area in Eastern Karakoram, which he has visited twice before, and (3) Mr. M. Escarra will lead a French Alpine Club Expedition next summer, to explore the peaks about Baltaro Glacier, including the well-known K_2, the second highest peak in the World.

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The first annual conference of the Bengal Pharmaceutical Association was held during the first week of April, Mr. H. Cooper, Ph.C., presiding. In the course of his address, Mr. Premananda Das, Ph.C., as Chairman of the Reception Committee, said that the Association has been planned to bring together on a common platform all manufacturers, wholesalers, importers, chemists and druggists and compounders with a view to facilitate mutual exchange of ideas, co-operation and help to eliminate misunderstanding, difficulties, drawbacks and the most unhealthy competition in price-cutting against each other. The Association intends to start a Journal of its own which will serve as a medium for discussing topics of interest to pharmacists and distributing information in the variations in prices in the World's market.

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Death occurred on 19th March 1935 at the age of 73 of Dr. Carl Duisberg, Chairman of I. G. Farben-industrie and famous German Chemist who discovered benzopurpurin and benzozurin. He was an eminent economic thinker and industrial leader and held office as President of the Reich Federation of German Industry from 1925-1931.

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We acknowledge with thanks the receipt of the following :—

"Agricultural Gazette of New South Wales," Vol. XLVI, Part 2, February 1935.

"Actualités Scientifiques et Industrielles,"- Nos. 176, 190-192, 196, 199, 201, 204, 206-207, 209-218, 221-222, 226.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4292-95.

"Biochemical Journal," Vol. 29, No. 2, February 1935.

"American Journal of Botany," Vol. 22, No. 2, February 1935.

"The Journal of the Indian Botanical Society," Vol. 13, No. 4.

"The Journal of the Institute of Brewing," Vol. XLI (Vol. XXXII, New Series), No. 3, March 1935.

"Canadian Journal of Research," Vol. 12, No. 2.

"Chemical Age," Vol. 32, Nos. 817-820.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 3.

"Experimental Station Record," Vol. 70, Index Number.

"Forschungen und Fortschritte," Vol. II, Nos. 7, 8, 9.

"Transactions of the Mining & Geological Institute of India," Vol. 29, Part 4, March 1935.

"Indian Trade Review," Vol. XIII, No. 75, March 1935.

"Monthly Statistics of the Production of certain selected Industries of India," No. 8, 1934-35.

"The Indian Forester," Vol. LXI, No. 4.

"Communications from the Kamerlingh Onnes Laboratory of the University of Leiden," Nos. 229-232 ; and Supplement No. 76 to Nos. 229-240.

"Forest Research in India," 1933-34, Part II, Provincial Reports.

"Bulletin of the Geological Institution of the University of Upsala," Vol. 24.

"Research and Progress," Vol. I, No. 1, January 1935.

"Half-Yearly Journal of the Mysore University," Vol. 7, No. 2.

"Memoirs of the Indian Meteorological Department,"—Vol. 6, Nos. 61-62 and Vol. 5, Nos. 46-60 Table of contents and errata.

"Nature," Vol. 135, Nos. 3408-3411.

"Natural History," March 1935.

"Acta Phytogeographica Suecica," VI, die-Verbreitung der Höheren Wasserpflanzen in Nordeuropa. By Gunnar Samuelsson.

"The Journal of Chemical Physics," Vol. 3, No. 3.

"Journal de Chimie Physique," Vol. 32, No. 2.

"Indian Journal of Physics," Vol. 9, Part III.

"Proceedings of the Indian Association for the Cultivation of Science, Vol. 18, Part III.

"The Indian Trade Journal," Vol. CXVI, Nos. 1499-1503.

"Arkiv för Zoologi," Band 27, Häftes 1 & 2.

Academies.

Indian Academy of Sciences.

(*Proceedings*, 1935, No. 9, March.)

SECTION A.

C. V. RAMAN: *On Iridescent Shells, Part I.—Introductory.*—W. T. Schmidt's elaborate investigation on the chemical and physical nature of the nacreous substance is summarised. C. V. RAMAN: *On Iridescent Shells, Part II.—Colours of Laminar Diffraction.*—The characteristic iridescence of shells is a diffraction effect which appears as one of the orders of spectra produced by the periodic structure at the surface of the shell. S. CHOWLA: *On Sums of Powers (II).* S. CHOWLA: *Note on Hypothesis K of Hardy and Littlewood.* J. B. SETH: *A Regularity observed in the Second Spark Spectrum of Iodine.* AKSHAYANANDA BOSE: *The Weiss Constant of Paramagnetic Ions in the S-State, Part I.—Aqueous Solutions of Manganous Salts.*—Careful measurements on aqueous solutions of $MnCl_2$, $Mn(NO_3)_2$, and $MnSO_4$ show that there is no deviation from the theoretical simple Curie law of temperature dependence. A moment of 29.3 to 29.4 Weiss magnetons is found for Mn^{++} ion, in agreement with the theoretical value 29.4. G. V. JADHAV AND Y. I. RANGWALA: *Bromination of Substances containing two Aromatic Nuclei, Part II.—Bromination of Phenyl and Cresyl Esters of m- and p-Nitro Benzoic Acids.*—It is found that bromination proceeds readily without a carrier with phenyl *m*-nitro-benzoate and phenyl and *o*- and *m*- cresyl *p*- nitro-benzoates, while with other esters, the presence of nitric acid is necessary. HANSRAJ GUPTA: *On the p-Potency of G (n, r).* H. LESSHEIM AND R. SAMUEL: *On the Pair Bond Theory of Valency.*—Chemical union is regarded as mainly an effect of the degeneracy due to the electrons. This leads to an electron pair bond theory of valency. According to this view, which is supported by spectroscopic evidence, the various additional hypotheses such as the octet rule and its extensions are unnecessary.

SECTION B.

B. N. SINGH, R. B. SINGH AND K. SINGH: *Investigations into the Water Requirement of Crop Plants.*—The paper deals with the water requirements of 57 different species and varieties of crop plants grown at the Experimental Station of the Institute of Agricultural Research, Benares Hindu University. B. N. SINGH AND R. K. TANDON: *Temperature-absorption characteristics during germination in seeds of different structure and biochemic constitution under varying concentrations of oxygen and water supply.*—The results of an experimental study of water absorption in thirteen varieties of seeds at different temperatures and three distinct environmental conditions—maximum water—no free oxygen; moisture and air conditions maintained at optimum level; and atmospheric moisture with free aeration. B. R. SESHACHAR: *The Golgi bodies in the Erithrocytes of* Ichthyophis glutinosus. T. EKAMBARAM AND RAMA RAO PANJE: *Contributions to our knowledge of* Balanophora.—Investigations of a South Indian form of *Balanophora dioica* R. Br., show that the life-history of the plant is a normal angiospermous sexual cycle with reduction-division (normal type) and a strong evidence of fertilisation. COL. I. FROILANO DE MELLO: *On two spiral organisms living in the intestinal tract of* Gallinula chloropus, L.—One type, treponema, identified as an avian variety of *spirochæta eurygirata* Werner *emend* Fantriasm; the other type, spirella, differing from the genotype *S. regandi* in having two anterior flagella and classified as *spirella gallinulæ* sp.n. K. M. GUPTA: *Critical remarks on* Dipterocarpoxylon Burmense *Holden.*—Irrawadioxylon *Gen. Nov.* S. K. PANDE: *Notes on the Anatomy of a Xerophytic Fern,* Niphobolus adnascens *from the Malay Peninsula.*—This epiphytic fern shows well-marked xerophytic adaptations. K. RAMIAH, N. PARTHASARATHY AND S. RAMANUJAM: *A Tetraploid plant in Wild Rice*—Oryza Longistaminata.—For the first time a tetraploid plant of *Oryza Longistaminata* is described.

Reviews.

THROUGH SPACE AND TIME. By Sir James Jeans. (Cambridge University Press, 1934.) Pp. vi+224. Price 8*s*. 6*d*. net.

Some one has described Sir James Jeans as a "man of science" who is also an artist. To this we may aptly add that he is a literary scientist. The lay reader eagerly welcomes any composition from the pen of Sir James Jeans, as he has the unique gift of making the story of science fascinating to the general reader.

The book under notice is the latest of Sir James' popular books on Astronomy and Astrophysics. It is based on the series of lectures delivered by him at the Royal Institution during the Christmas of 1933. The book itself is divided into eight chapters under the following headings:—The Earth, the Air, the Sky, the Moon, the Planets, the Sun, the Stars and the Nebulæ.

At the very outset the author proposes to take his readers on an imaginary journey through space and time and make them see for themselves the wonders of the universe. To begin with, in the first chapter, we are asked to delve into the bowels of the Earth. Here the author tells us the story of evolution in a simple and attractive manner. The prehistoric dinosauri and other monsters are brought before us and we learn of them

as if at first hand. The picture of the Diplodocus as a monster weighing as much as a whole family of elephants—"Father, mother, children and perhaps several uncles and aunts as well"—is amusing if not entirely truthful.

The chapter on "the Air" is mainly meteorological—treated so as to make it interesting to people who have not had the advantage of being trained in that science.

In the first two chapters Sir James Jeans is not in his element—he is not a palæontologist or a meteorologist though he has the rare faculty to make anything he handles interesting.

In the third chapter, the classical theories of cosmogony of Ptolemy, Hipparchus and others are lucidly expounded so that even children could peruse them with profit. A notable point in this connection is the way in which Sir J. Jeans explains away the difficulties raised by Tycho Brahe—who could not understand why the sky did not change in appearance from time to time if the earth were moving in space. Jeans compares the earth to a rose bud in a vast garden and man crawling like a green fly on the rose bud could not discover any re-arrangement in the remote reaches of the garden—and for the same reason we are unable to detect any change in the arrangement of the stars even though the earth is hurtling in space at the rate of about 18 miles per second. The problem of the expanding universe has been propounded in an admirable manner and the comparison of the nebulæ to drifting straw bits on an ever-widening river is particularly striking as it effectively brings home to the mind of the reader such an abstruse thesis as this.

Certain very minor slips have crept in, probably during the passage of the book through the press, as for example, on page 142 where a reference is wrongly made to an illustration of Mercury.

The book, we have no doubt, will be a very useful addition to all public and private libraries—and must certainly be read by every one who wishes to be acquainted with the recent scientific developments. The attractiveness and simplicity of style and the homely exposition of abstruse scientific theories, must create a great demand for this book. We regret that we have no such Institution in India which could arrange similar lectures. Sir James Jeans is always read with avidity wherever English language is spoken and in this little book he excels himself. We hope that many more equally entertaining and informative books will be forthcoming. This little book deals with great problems in an easy and charming manner which every great scientist and school boy can read with profit and pleasure.

C. N. R.

L'ELECTRON POSITIF (No. 182 of Actualités Scientifiques et Industrielles). By Irène Curie and F. Joliot, Paris: Hermann et Cie. 1934. Price 10 fr.

The contributions of Mme. Irène Curie and M. F. Joliot to the subject of the present volume have been of fundamental importance. After the discovery of the positron by Anderson had received confirmation by the work of Blackett and Occhialini, Curie and Joliot showed that the positrons must be due to the conversion of γ-rays into matter. The whole story of these discoveries is well told in the brochure before us which provides an authoritative and complete account of the experimental studies dealing with the positron. The theoretical aspects are only mentioned in passing. Four plates containing beautiful photographs of the tracks of positrons enhance the value of the work. We should like to mention in passing that calling the positive electron sometimes as positron but more often as positon leads to some confusion. Similarly the abbreviation for electron-volts is given variously as eV., *ev.*, and e.V. Apart from these minor matters, and some three typographical errors on p. 3, l. 7, p. 8, l. 2 from bottom and p. 11 legend to Fig. 3, we have no hesitation in welcoming the appearance of the monograph as most opportune.

T. S. S.

THE POETRY OF MATHEMATICS AND OTHER ESSAYS. By David Eugene Smith. Published by Scripta Mathematica, Yeshiva College, Amsterdam Avenue and 186th Street, New York. N.Y.

This is a neat little book of four popular essays by the well-known author of the History of Mathematics. The object of the author seems to be to furnish material which will interest not only teachers of mathematics but all who recall their contact with the subject in their school or college days.

The first essay deals with features common to poetry and Mathematics, such as Imagination, Rhythm and Symmetry. The second gives a really novel view of looking

at Religion in a mathematical way, namely, drawing inferences from a definite set of postulates. The author has given a lead to the theologians by a model example.

The third and the fourth articles are merely biographical notes on Thomas Jefferson, President of the United States, who took a great deal of interest in Mathematics and especially Astronomy and M. Monge, the celebrated mathematician of differential-equations fame and his association with the French Republic as Minister of Marine and later with Napoleon Bonaparte. It is curious that in France of all countries mathematicians easily find a place in the government of their land, the late M. Painlevé being the most recent and outstanding example.

The essays are extremely readable and interesting to the professional as well as the amateur mathematician, and the book will easily be a useful addition to all our school and college libraries.

B. M. N. R.

ANALYSE DES MECANISMES CHIMIQUES CHEZ LES ETRES VIVANTS. By T. Cahn. (Hermann et Cie, Paris, 1934, Pp. 23.) 8 fr.

The composition of several biologically occurring substances is little known, the concentration in which they occur is too small in many cases, and the physico-chemical conditions in which they exist also play an important part. In spite of all these difficulties, chemical analysis of the organisms can give important information regarding the mechanism of the reactions in living bodies. After an interesting introduction to the subject, the author has given in this monograph an account of particularly the diastatic reactions occurring in the tissues, and the knowledge that can be gained about their mechanisms from a study of the concentrations and nature of the coferments occurring in them.

M. A. G.

HYDROSTATICS AND MECHANICS. By A. E. E. McKenzie, M.A. (Cambridge University Press, 1934. Pp. 272.) Price 3*s*. 6*d*.

The book is the first of three volumes covering the sections into which Physics is usually divided and deals with that portion which is usually regarded by students as the dullest part of the subject; but the author has eminently succeeded in presenting the subject in an interesting and practical, and therefore useful, manner. In dealing with pressure in liquids, an account is given of utilisation of water power by harnessing water falls and building dams across rivers, and the practical aspect is stressed by calculations made without entering too much into technicalities—an aspect which deserves to be emphasised in high schools and intermediate colleges. Similarly, practical treatment is adopted in dealing with the principle of Archimedes, theory of machines, and the parallelogram law. The diagrams are very neat and the pictures lucid. Examples worked out are apt.

The book deserves a place in the libraries of high schools and junior colleges.

K. N. KINI.

SIMPLE SCIENCE. By E. N. da C. Andrade and Jullian Huxley. (Basil Blackwell, Oxford. Pp. 688.) Price 8*s*. 6*d*. net.

There is a feeling among educationists that all is not well with the science syllabus in the secondary school. The remedy suggested is not so much a curtailment of the scope of the subjects as a judicious redistribution and inclusion of the biological sciences as an integral part of the course of study in science. Here, it may not be out of place to put in a word for greater attention to be paid to Biology. Though many phases of life are affected by scientific advance, and biology can claim a fair share of the credit, still it will hardly be too much to say that to most people Biology is only of secondary importance—Physics and Chemistry coming in for the largest share of their sympathy. Besides, it is thought that the interest in Biology is purely academic. However, it is refreshing to note that in the series of popular books which Professors Andrade and Huxley have written, they have in a great measure, overcome this shortcoming.

The book under notice is divided into three parts. In the first of these the authors have endeavoured to place before the young reader for whom it is intended a general outline of the Natural and Physical Sciences. In doing this the authors have developed a method that is all their own. Among several instances we may cite,—one feels particularly impressed by the way they stress,—"that all things obey laws". The law that governs Stellar motion can with equal facility be applied to the motion of every other moving system in the universe. Another admirable example of a simila

kind is the way they impress the imponderability of energy. Actually energy is not a material thing, but is an agency capable of different manifestations. To bring home this idea to the young reader the authors have by an array of ingenious examples striven their utmost. Needless to say they have succeeded completely. An abstruse concept such as Heredity is lucidly expounded and is treated in a laudable manner. Simply and clearly they have taught that like brings forth like.

In the second part—Science and Life (review *Curr. Sci.*, May 1933)—the elementary laws of Physics and Chemistry together with those of Biology are explained in a praiseworthy fashion and is a logical sequel to the first part.

In the third section—Forces of Nature—a more detailed and advanced treatment of the subject-matter of the two previous books is given. A notable feature of this book is that wherever possible the everyday aspect of scientific knowledge has been emphasised. Technical applications have been accurately described without the employment of jargon.

In conclusion, we have no hesitation in recommending this book as suitable for courses of study in the lower forms of secondary schools. We hope that the authorities will appreciate the efforts of the authors and lend them the support they so well merit. Again, we may congratulate Professors Andrade and Huxley on having produced this eminently readable work, deserving a place in all the libraries both public and private.

C. N. R.

YOUR MEALS AND YOUR MONEY. By Gove Hambidge, Whittlesey House. (McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C. 2. Pp. xvi+179. 1934.) Price 6*s.* net.

This is an interesting book full of practical suggestions for securing a complete diet based on different levels of income. It seems to us that the book will be found useful not only to parents but to the statesmen who are both concerned in the health and efficiency of the people. To the general Medical practitioner, it is almost indispensable.

The author bases his book on the U. S. Department of Agriculture circular called "Diets at Four Levels of Nutritive Content and Cost", by Hazel K. Stiebling and Medora M. Ward. It is almost superfluous to point out that a sound and detailed knowledge of food should have a direct bearing on agricultural policies. The cardinal principle of all such policies must be to encourage the production of the right kinds and the right quantities of foods, and it is obvious that the general public must have authoritative facts about diet in relation to their well-being, the standards of good nutrition and the factors in the selection of the right type of diet for the promotion of health and efficiency of people. In India the great majority of people have practically no knowledge of the nutritional requirements and standards and the nutritional values of common foods and especially in tropical countries where the climate is so inhospitable, every wage earner should have an adequate information about what to eat, how much to eat and how much to spend on himself and his family for food.

The book will, we expect, be received in India with enthusiasm. It gives in a simple and complete manner an account of the researches and conclusions of scientists, which result in fixing standards of nutrition for different classes of people; the practical bearing of these standards on their meals; the welfare of the nation which depends on how its members eat and the adjustment of agriculture from which the supply is obtained. A perusal of this extremely interesting book will convince the readers that the diet of the people affects their welfare and productive efficiency which in their turn determine the character of their agriculture The chief problem with the Indian population is what foods they should buy out of a given amount of money each week so as to secure the greatest possible nutritive value out of them. India wants definite dietary patterns for the use of her poor and rich families such as Stiebling has prepared for the use of American families and which are presented in the book with illuminating commentaries.

The book is divided into seven chapters, and the first one deals with the proximate principles and general problems. The second chapter which deals with "costs" deals with the family budget in relation to standards for safeguarding the health of its members. Four different plans are given over expenditure, and every one of these is calculated to ensure the necessary elements in correct proportion suited to age, occupation and finance. Naturally these plans or patterns discuss groups of foods and their contribution to the diet and the third chapter

is devoted to a detailed examination of each class of food-stuff in order to bring out the significance of balanced diets. The next two chapters discuss quantities and nourishment which are clear statements of scientific facts of great importance. Chapters six and seven which deal with thrift and national well-being are the most important sections of the book, and we can hardly think of any one who can afford to be independent of a complete knowledge of both. In the supplement is given retail prices of food materials used in computing costs for the four plans.

The chief merit of the book is its simple and clear exposition of the scientific researches and conclusions of a large body of American scientists and economists, and the wealth of information contained within its compass is as rich as it is varied. Indeed this is a family dietary book and every householder who can read and write the English language must possess a copy of it.

* * *

"ANALAR" STANDARDS FOR LABORATORY CHEMICALS. Formulated and issued jointly by the British Drug Houses, Ltd., and Hopkin and Williams Ltd., London. 1934.

There are perhaps very few publications in which the chemist will find such an indispensable wealth of material as the one before us; during the conduct of his scientific work, it is supremely important that he should be aware of the purity of the materials he handles and for this purpose, it is very desirable that he should avoid the tedious testing of the materials by being able to rely upon each substance conforming to a specific standard. This need is supplied to a generous extent by the book before us which has been published as a co-operative effort by Messrs. British Drug Houses Ltd., and Messrs. Hopkin and Williams, Ltd., the two well-known firms who have for several decades now principally concerned themselves with the manufacture of fine chemicals for Laboratory use. The term "laboratory chemicals" is used comprehensively to include "chemicals for analytical, research, teaching and all other laboratory purposes." The two Firms have hitherto had their individual books of standards and by pooling together their knowledge and experience their chemical staff have brought out a highly useful and up-to-date volume and thereby earned the gratitude of the Chemical world. The book deals with some 200 substances and in each case the physical and chemical properties are listed and thus forms a valuable record of the chief properties of the chemicals with which it deals. Quantitative assays for the chemicals have been prescribed and the minimum percentages specified. The maximum limits of impurities are also listed.

The book deserves to find a place in the hands of every chemist. It may also be mentioned here that the Firms have now placed on the market all the laboratory chemicals listed in the volume, under the trade name "Analar" which carry a guarantee of "purity".

VIRUS DISEASES OF PLANTS. By John Grainger (Oxford University Press, London. Pp. 102.) Price 6*s*. net.

The subject of virus diseases of plants is one of great interest not only to those who are interested in the fundamental aspects of the problem but also to practical agriculturists who are deeply concerned with the welfare of their crops which are affected by a number of virus diseases. Dr. Grainger's contribution to this subject in the form of a text-book provides introductory information on this important aspect of plant pathology.

The author has incorporated a good deal of his own experience in this field and the experimental technique described on some aspects of the subject provide sufficient detail for enthusiasts to conduct experiments on the field with crops which may be affected with disease. The numerous references cited at the end, constitute a useful feature of the volume.

M. S.

BIOLOGY FOR EVERYMAN. By Sir Arthur Thomson. 2 Vols. Edited by E. J. Holmyard. (J. M. Dent & Sons, Ltd., London. Pp. 1600, 1934.) Complete Price 15*s*. net.

We have taken some time in reading these two volumes, and as we were not obsessed by any apprehensions of an Examination, we must say at once that we have derived great pleasure and instruction from their perusal. Thomson was always a skilful writer, possessed a clear and delightful style, besides a complete knowledge of all the branches of Biology. The present volumes which are full and authoritative are a great achievement, surpassing any of his previous publications in scope and treatment. Singularly enough they do not produce the nausea usually associated with Text-Books and the intention of the author as well as that of the publishers, *viz*., that they should

be read by "everyman" without being bothered by technicalities and professional detail, is admirably fulfilled.

The two volumes are divided into four books. The first volume is taken up with Book I which is devoted to the treatment of the anatomical characteristics, taxonomy, bionomics, ecology and ancestral history of the members of the different phyla of the animal kingdom. The second volume comprises the next three books. The second book deals with the general principles and philosophy of Zoology. The plant world is considered in Book III, and in sixteen chapters, we have a clear and adequate account of the flowering and non-flowering plants. The fourth Book is exclusively occupied with the story of man. Every chapter is attractive and instructive, and the entire exposition is simple and eminently readable. Even the lay reader is able to follow the argument of the fundamental scientific principles, while the students of biology are offered a constructive and synthetic exposition of the different aspects of biological knowledge. The book may be used therefore by the general reader for appreciating the biological phenomena and by the systematic students of science for purposes of examination. To combine the interests of these two classes of readers, which are not entirely identical, is a task worthy of a great scientist, and the two volumes represent a landmark in the history of scientific books. They constitute a great and indispensable publication useful alike for study and reference.

Towards the close of the second volume the author strikes a high ethical note, and we cannot conclude this brief review better than quote the following impassioned passage:

"Thus the cup of joy or sorrow may be too full to hold without some expression of religious feeling; or man may find himself balked practically when he has done all that mortal man can think of; or he may bow over-awed in face of the mysteriousness of Nature and his place in it. The expressions of the religious mood may be primitive hardly rising above an appeal to magic or relapsing to that ancient system of belief, but they are sometimes so noble that they must be ranked among man's highest achievements. On the intellectual side, they often join hands with philosophy, on the emotional side with art, on the practical side with the endeavour after goodness; but the word 'religion' is misused if it does not imply a recognition of the mystical or spiritual. In some way and in some degree the religious man is always sending out tendrils towards the Supreme Reality; which he usually names to himself as God."

ELEMENTARY MICROTECHNIQUE. By H. A. Peacock. (Edward Arnold & Co., London, 1935). Pp. vi+200.

Mr. Peacock deserves to be congratulated on his extremely useful book on Microtechnique for beginners. The new book by Mr. Peacock, under review, gives us in the first few pages an exact and current idea of the structure of the cell including the emulsoid nature of protoplasm and also a brief account of the protoplasmic and metaplasmic bodies. After describing the objects of fixation (*viz.*, to obviate postmortem changes, to raise the refractive index, to increase the resistance of cells to solutions of varying osmotic pressures and to become amenable to stains), staining (where the physical and chemical theories are touched upon), differentiation, etc., the author gives a tabular statement (which is a ready reckoner) of the more important fixatives and their actions on cells and tissues. In the chapters on methods for specific purposes and uses of stains, he deals with the various fixatives and stains which can be used for the demonstration of the various organs of the different groups of animals and plants. The next chapter—Formulæ and Hints—is not only useful to the student working in a histological laboratory but also to a research worker. As the book aims at broadcasting only elementary microtechnique, the important subjects like fixation and differential staining for the protoplasmic and deutoplasmic bodies in the cells and also the various methods for the nerves and their peculiar endings are omitted. We would certainly welcome a book which gives us a comprehensive and authentic data for the clear exposition of the mitochondria and golgi bodies and various kinds of fats by select and differential staining.

The get-up of the book is excellent and we recommend it to every beginner in the field of microscopic anatomy.

The book contains three appendices in which valuable information is given on the sources and culture of material, the preservation of material and finally a complete bibliography.

L. S. R.

CONFESSIONS OF A SCIENTIST. By Raymond L. Ditmars. (The MacMillan Co., New York, 1934.) Pp. xii+241. Price 10*s.* net.

Readers of Dr. R. L. Ditmars' *Reptiles of the World* will welcome this book which is, however, full of interest not only to the

scientist, but also to the general readers. It is true that there are not very many thrilling experiences recorded in this book, but the account of his scientific expeditions and his descriptions of the habits of some of the animals kept in the Zoological Park, New York, furnish extremely interesting and profitable reading. Dr. Ditmars has loving sympathy for the animals in his charge, is an intrepid explorer forgetting dangers in the midst of excitement, a remarkable power of observation and has a quaint manner of telling his experiences, and a combination of qualities which impart to his books the interest and wide circulation which they deserve.

The first chapter gives an account of the fruitless adventure in Panama in quest of bushmaster, a deadly viper with a head about the size of a man's fist, and the snake itself attaining nine feet. Instead of the dangerous prize he was seeking after, Dr. Ditmars obtained a baby boa constrictor in the cabin of the ship's captain. He accepts his failure in the spirit of a sportsman. The second chapter opens with an account of the author's talk on the "dragon" lizard, iguanas and a large tarantula. This is followed by the story of a hunt for crickets and cockroaches. The chapter is full of humour. Two chapters (III and XIII) are devoted to the treatment of the habits of vampire, a blood-licking bat of the tropical America and some new observations on their mode of locomotion on the ground, their feeding and their appearance after a full meal are recorded. Every chapter is fascinating. The author is also a film producer. To produce moving pictures of animals even in cages, especially of such dangerous ones as the mamba, is always attended by perilous excitement. Chapters VII, VIII and IX deal with this phase of activities of Dr. Ditmars. Chapters X and XI inform us about the use of cobra venom in the treatment of malignant tumours and of the poison of Tarantula in that of leprous growth. There is incidentally an account of the motion picture taken through the microscopes by Dr. Heinz Rosenberger, of the "good" and "bad" cells and the rôle they play in the production of abnormal tissues. The most amusing episode in the book is the successful theft of ten of the most beautifully coloured snakes in the collection and the offenders proved to be school boys whose zeal for science had temporarily obscured their sense of misdemeanour.

We scarcely remember reading a more interesting book in natural history. This one is packed with information over a wide range of subjects, and is told in a crisp style relieved by delicate touches of humour. It is an excellent companion to the author's bigger book *The Reptiles of the World*. We have read a most enjoyable book.

A GERMAN-ENGLISH DICTIONARY FOR CHEMISTS. By Dr. Austin M. Patterson. Second Edition. 1935 (John Willey and Sons, Inc.; London, Chapman & Hall Ltd.) Price 15*s*.

Since its first publication in 1917, this book (so also its companion volume—the French-English Dictionary by the same author) has won the reputation of being invaluable to all English-knowing chemists. This cannot be otherwise, as there are few books which are equally handy, and yet provide such a useful assemblage of word-meanings.

The present edition comprises about 42,000 entries and as the author has mentioned in the preface, reflects the growth of the science. The author has been assisted in his task, among others by the staff of the *Chemical Abstracts* who, more than anybody else, are in a position to point out new German words and their meanings that have come into common usage in chemical literature. The blue additional sheets which were so conspicuous in the later impressions of the previous edition have now disappeared and the present vocabulary with its familiar flexible binding will be welcomed by all. A book so well-known to the Chemists, the world over, needs no elaborate notice; we have only to commend to their attention the new edition with a large number of new entries and numerous additional meanings of old words.

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